USSR Report

PHYSICS AND MATHEMATICS

No. 51

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Virginia 22201.

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. JPRS 74007	2.	3. Recipient's Accession No.

4. Title and Subtitle
USSR REPORT: PHYSICS AND MATHEMATICS, No. 51

5. Report Date
14 August 1979

6.

7. Author(s)

8. Performing Organization Rept. No.

9. Performing Organization Name and Address
Joint Publications Research Service
1000 North Glebe Road
Arlington, Virginia 22201

10. Project/Task/Work Unit No.

11. Contract(C) or Grant(G) No.
(C)
(G)

12. Sponsoring Organization Name and Address

As above

13. Type of Report & Period Covered

14.

15. Supplementary Notes

16. Abstract (Limit: 200 words)

The report contains articles, abstracts and news items on aerohydrodynamics, magnetohydrodynamics, physics of crystals and semiconductors, molecular, atomic and plasma physics, optics, spectroscopy, physical measurements, and on theoretical and applied mathematics.

17. Document Analysis a. Descriptors

USSR
Acoustics
Optics
Lasers
Nuclear Physics
Structural Mechanics
Plasma Physics
Mathematics

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group 12A, 20A, 20E, 20F, 20H, 20I, 20K, 20M

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited Availability Sold by NTIS Springfield, Virginia 22161	UNCLASSIFIED	74
	20. Security Class (This Page) UNCLASSIFIED	22. Price

(See ANSI–Z39.18) See Instructions on Reverse

OPTIONAL FORM 272 (4–77)
(Formerly NTIS–35)
Department of Commerce

USSR REPORT

PHYSICS AND MATHEMATICS

No. 51

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CALCULATION OF THE ACOUSTIC VELOCITY AND LOGARITHMIC DECREMENT IN
POLYDISPERSE VAPOR-LIQUID MIXTURES

RADOVSKIY, I. S., Moscow Institute of Engineering Physics

[Abstract] The acoustic properties of polydisperse 2-phase media such as
liquid-vapor mixtures are determined by relaxation processes and can be cal-
culated on the basis of spontaneous equilibrium recovery after a unit-step
perturbation. Calculation of the acoustic velocity and logarithmic decre-
ment requires only one equivalent diameter representing the range of
particle diameters in the medium. This diameter depends on the probability
density of diameters and is determined here assuming either a normal or a
log normal distribution. References 11: 8 Russian, 3 Western.

USSR   UDC 536.423

EXPERIMENTAL DETERMINATION OF THE VELOCITY OF ULTRASOUND IN SUPERHEATED
ORDINARY AND HEAVY WATER

YEFSTEFEYEV, V. N., SKRIPOV, V. P. and CHUKANOV, V. N., Ural Science Center,
USSR Academy of Sciences

[Abstract] The velocity of ultrasound in superheated (metastable) ordinary
and heavy water was measured with a small acoustic cell made of Pyrex
glass inside a thermostat at six temperatures covering the 150-300°C
range. Isotherms of the acoustic velocity as a function of the pressure
are calculated from these data, and subsequently the isothermal and the
adiabatic compressibility as well as the coefficient of thermal expansion
and the ratio of specific heats on the basis of the appropriate equation of
state and other relevant thermodynamic relations. Figures 2; tables 2;
references: 12 Russian.

EXPERIMENTAL STUDY OF WATER WITHIN THE CRITICAL LIQUID-VAPOR RANGE WITH
THE AID OF ULTRASONIC VELOCITY MEASUREMENTS

YEROKHIN, N. P. and KAL'YANOV, B. I., Taganrog Pedagogical Institute

[Abstract] Anomalies of water were studied with the aid of ultrasonic
measurements along its critical isotherm (647.23 K), critical isochore, and
liquid-vapor equilbrium line on the liquid side. The velocity of ultra-
sound at four frequencies (0.48, 1.47, 2.55, 3.55 MHz) was measured by
acoustic continuous interferometry in a thermostat or in an autoclave.
Here the results are shown, the dispersion of the acoustic velocity inter-
preted on the basis of the dynamic scaling theory and the exponent of the
specific heat calculated from the polynomial temperature dependence of the
adiabatic compressibility. The authors thank S. L. Rivkin, A. A. Aleksan-
drov and M. A. Anisimov for the helpful discussion of both the methodology
and the results. Figures 5; tables 3; references 18: 12 Russian,
6 Western.

ABSORPTION OF SOUND IN ELECTRICALLY NONHOMOGENEOUS SEMICONDUCTORS

KETIS, B. P. and KRIVKA, I., Vil'nyus State University imeni V. Kapsukas

[Abstract] The absorption of an acoustic wave is considered in electrically
nonhomogeneous semiconductors where the linear geometric dimensions of
carriers of nonhomogeneous concentration in adjacent macroregions are much
shorter than a wavelength, these regions being represented as Maxwell-
Wagner macrorelaxers. The semiconductor specimen is treated as a homogene-
ous dielectric with a certain time of relaxation of the polarization
induced by the electric field of the wave, and with straight-through con-
ductance. An attempt is made to account for the barrier model of photo-
conductivity of semiconductors in the analysis of acoustoelectric inter-
action. An expression is found for the coefficient of electron absorption
as a function of the straight-through conductance of the crystal for an
arbitrary ratio of macroregion conductivity and linear dimensions in the
direction of the electric field. The theoretical results are compared with

experimental data for CdS crystals, and it is concluded that these crystals contain regions with different conductivities. Figure 1, references 5: 3 Russian, 2 Western.

EFFECT OF DOPING ON CRITICAL POINTS AND HYSTERESIS OF MARTENSITE TRANSFORMATION IN TiNi

CHERNOV, D. B., BELOUSOV, O. K. and YE. M. SAVITSKIY, associate member, Academy of Sciences USSR, Moscow, Institute of Metallurgy imeni A.A. Baykov, USSR Academy of Sciences

[Abstract] Critical points and hysteresis are the principal characteristics of martensite transformation, and in materials with shape memory such characteristics are of practical importance since they determine the temperature ranges of performance of alloys. In this connection alloys in the TiNi-TiFe, TiNi-TiCo, TiNi-TiCu, TiNi-TiSi cross sections of the corresponding ternary systems as well as in the radial cross sections TiNi-Cu, TiNi-Si, TiNi-Al, and TiNi-Ge were investigated. Rod-shaped specimens measuring 5x60 mm were cast and the temperatures of direct and reverse martensite transformation were determined for specimens heated to 250°C and cooled to-196°C while under a bending moment of 5 kg/mm^2. The findings were used to plot temperature-strain diagrams and temperature-hysteresis diagrams. For alloys with differing Cu content (4 and 10 mol.% TiCu) the hysteresis loop of thermoelastic transformation increases with increase in Cu content. Of the alloying elements Fe affects most substantially the decrease in the martensite start point. On the other hand, Fe and Co affect the hysteresis insignificantly, while Si reduces it. The various alloying elements can be arranged in a series according to the degree of their effect on the broadening of the temperature range of transformation: Cu > Co > Fe > Si, the physical explanation being the effect of these elements on the total number of (s+d)-electrons in TiNi and the fact that Cu, with its positive parameter of interaction with the hexagonal close packed Ti will reduce the forces of interatomic bonding in TiNi, thus leading to a broadening of the temperature range of transformation to ~200°C. A similar effect is observed on investigating the interaction between the alloying elements and Ni. Moreover, a number of physical parameters of the elements (e.g. the characteristic Debye temperature) will display the same sequence. Thus it can be concluded that elements enhancing the forces of interatomic bonding in TiNi will reduce its transformation hysteresis, while elements weakening these forces will increase its hysteresis. This pattern can be extended to other elements, and it is of practical importance when selecting alloys with the shape memory effect. Figures 3; references 11: 9 Russian, 2 Western.

BASIS MAGNETIC ANISOTROPY OF THE WEAK FERROMAGNETIC $FeBO_3$

DOROSHEV, V. D., KRYGIN, I. M., LUKIN, S. N., MOLCHANOV, A. N., PROKHOROV, A. D., RUDENKO, V. V. and SELEZNEV, V. N., Simferopol' State University imeni M. V. Frunze; Donetsk Physico-Technical Institute of the Ukrainian SSR Academy of Sciences

[Abstract] The antiferromagnetic resonance method (AFRM) was used to measure the hexagonal magnetic anisotropy in the basis plane of crystals of rhombohedral weak ferromagnetic $FeBO_3$ (spatial symmetry group D_{3d}^{2}). The anisotropy field was determined according to the displacement of the resonance line of the low-frequency branch of the AFRM during the rotation of a permanent magnetic field in the basal plane of the crystal. This led to the discovery of a compensation temperature $T_c = 5$ K at which the effective field of hexagonal anisotropy H_{eq} reverses its polarity. As a result, below T_c the state in which the antiferromagnetism vector is parallel to one of the second-order axes of C_2 is convenient from the standpoint of the energy balance, and hysteresis of the resonance field is observed in the neighborhood of T_c. The findings warrant the assumption that crystals of iron borate synthesized by various technologies contain impurities which at low temperatures affect the width of the AFRM line and the anisotropy energy in the basis plane. On the other hand, the change in the sign of H_{eq} and the corresponding spin reorientation may be intrinsic properties of pure $FeBO_3$. Additional studies have been undertaken to elucidate these questions. Figures 2; references 7: 5 Russian, 2 Western.

MAGNETOCONCENTRATION EFFECTS IN AN EXTRINSIC SEMICONDUCTOR WITH ESSENTIALLY DIFFERENT ELECTRON AND HOLE MOBILITIES

GRIBNIKOV, Z. S., GUGA, K. YU., MALOZOVSKIY, YU. M. and MALYUTENKO, V. K., Institute of Semiconductors, Academy of Sciences Ukrainian SSR

[Abstract] It is usually assumed that the magnetoconcentration effect (MCE) and analogous bipolar anisotropic effects with thermal generation of current carriers manifest themselves most markedly in intrinsic semiconductors. But this is true only when the electron and hole mobilities μ_n and

μ_p are similar in value; when they differ considerably these effects can also be substantial in essentially extrinsic semiconductors. In this connection, the MCE in p-type indium antimonide with the excess acceptor concentration $p_0 - n_0 = N = (2 - 7) \cdot 10^{14}$ cm^{-3} was investigated at temperatures of 100-230 K. The current-voltage characteristics of thin plates of a thickness of the order of the diffusion lines were measured in transverse magnetic fields. The experiment demonstrated strong temperature dependence of the influence that the magnetic field has on the voltage-vs-current curve with a maximum at T = 160 K. This dependence is however limited by local depletion due to contact exclusion. Figures 3; references 4: 3 Russian, 1 Western.

AKHMANOV, S. A., ZHDANOV, B. V., ZHELUDEV, N. I., KOVRIGIN, A. I. and KUZNETSOV, V. I., Moscow State University imeni M. V. Lomonosov

[Abstract] The NOA effect (dependence of the angle of turn of the polarization plane on the light intensity) in crystals, due to "fast" electron nonlinearity, is here investigated for the first time. The isolation of the true electron NOA against the background of slower thermal effects and parasitic signals due to frequency instability and the dispersion of linear activity, was accomplished with the aid of a specially developed two-channel pulsed polarimeter serving to record the variation in the angle of turn of the polarization plane within the duration of a single laser pulse ($\tau = 10^{-8}$ sec). A crystal of LiIO$_3$ with a relatively high susceptibility was selected as the medium of investigation, and the NOA effect was investigated in that crystal at the frequency of the second harmonic ($\lambda = 0.532\mu$) of a single-frequency Nd-YAG laser: the constant of nonlinear rotation measured at that frequency was found to be $(1\pm 0.6) \times 10^{-11}$ deg·cm· watt. Research into NOA in liquid crystals is of major interest in this connection: the use of tunable lasers will make it possible to develop NOA as a new method of nonlinear polarization spectroscopy providing unique information on both anharmonicity and spatial dispersion. The relationship between NOA and the quadratic electrogyration effect is of major interest to crystal spectroscopy and should be the subject of a future investigation. Figures 2; references 10: 7 Russian, 3 Western.

SPUTTERING DIELECTRIC FILMS BY MEANS OF THE EMISSION OF A CW CO_2 LASER

POZDNYAK, N. I. and MYL'NIKOV, V. S.

[Abstract] Thin films of the dielectrics MgF_2, SiO_2, TiO_2, ZrO_2 and the cermet $Ag-SiO_2$ are sputtered by means of a CW CO_2 laser and a study is made of the optical and structural properties of these films. The emission of the CO_2 laser is focused by a metal mirror on a spot measuring 2 to 15 mm^2, enabling a power density at the target of from 10^2 to 10^3 W/cm^2. The targets consist of pressed pellets in the case of MgF_2, TiO_2, ZrO_2 and $Ag-SiO_2$, fused quartz in the case of SiO_2, and a crystal in the case of MgF_2. The distances from the target to the substrates vary from 90 to 150 mm, and the sputtering rates in Å's are as follows: 0.3 to 0.6 for ZrO_2, 0.3 to 1 for TiO_2, 1 to 3 for SiO_2 and $Ag-SiO_2$, and 1 to 15 for MgF_2. The chamber is evacuated with a TML-200 turbomolecular pump. Used as substrates are glass, fused quartz, fluorite, silicon and NaCl chips. Substrates are prepared for sputtering by chemical etching and rinsing in circulating distilled water and alcohol. A gas discharge at $5 \cdot 10^{-2}$ mm Hg is used for final cleaning. Film thickness is measured with an MII-9 microinterferometer, the refractive index by the ellipsometric method; absorption spectra in the 200 to 1100 nm region are recorded with an SF-16 spectrophotometer. Films of the oxides SiO_2, TiO_2 and ZrO_2 and the cermet $Ag-SiO_2$ can be produced only by sharp focusing of the emission, to ensure a power density at the target of not less than 10^3 W/cm^2. Of particular interest is the employment of this method for producing cermet films, which are presently used extensively in optics and electronics. The cermet sputtered here is based on 10 percent Ag and 90 percent SiO_2. A photomicrograph produced with an electron microscope is shown for a film of this cermet on a quartz substrate. The percentage content of the metallic phase in the film is increased 30 percent as compared with the target. Figures 3: references 8: 5 Russian, 3 Western.

STUDY OF THE EMISSION PROPERTIES OF ALKALI-EARTH METAL OXIDES IN A STREAM
OF CO_2

ASTRAKHANTSEVA, V. F. and NIKONOV, B. P.

[Abstract] A study is made of the changes in the emission properties of
BaO and an oxide cathode poisoned by a stream of CO_2, and of the subsequent
restoration of emission in a vacuum. The studies were performed on a
cathode 3.2 mm in diameter. covered with alkali-earth metal oxides. It is
found that the interaction of the cathode at less than 650 K is a surface
reaction with adsorption of the CO_2 oxygen at vacancy sites of the oxygen
sublattice on excess surface barium atoms. Figures 2; table 1, references
9. 5 Russian, 4 Western.

PECULIARITIES OF THE EMISSION FROM TRANSPARENT DIELECTRICS EXPOSED TO
LASER RADIATION

BYKOVA, T. T., YEFIMOV, YU. P. and TYUTIKOV, A. M.

[Abstract] A study is made of the emission of transparent dielectrics
exposed to laser irradiation in the subthreshold region, i.e. when a target
is exposed to laser radiation with a power density of about half the
threshold power of visible damage to the surface. The study is made using
a time-of-flight mass spectrometer and Q-switched ruby laser with the
specimen in the center of a high vacuum chamber. Charged particle emission
from various dielectrics was studied: single crystals of alkali halide
compounds, single crystals of ZnS, polycrystalline layers of ZnS, glass and
quartz. For all specimens, positive ions and electrons were emitted
before the optical breakdown threshold. The optical breakdown threshold
was assumed to be that intensity of laser radiation at which a light flash
was recorded by the electron multiplier used to record the emitted par-
ticles: There was no correlation between the content and number of
impurities with the composition of emitted ions in the study of emission
with LiF. When the power was over half the breakdown threshold, consider-
able broadening of emission peaks compared with laser peaks was observed.

In the mechanism of thermal breakdown of transparent materials, heating
of the medium occurs due to heating of absorbing heterogeneities by the
light field. The rate of propagation of the leading edge of the heat wave
and the distance of the absorbing center from the surface determine the
delay in emission. Emission delay may also result from thermoelastic
stresses within the centers of energy absorption, resulting in the develop-
ment of cracks which, when they reach the surface, may transmit large num-
bers of electrons and ions. Table 1, figures 2, references 12: 8 Russian,
4 Western.

STUDY OF THE SURFACE GLOW OF SINGLE CRYSTALS OF (111) Mo, (111) Ta AND
POLYCRYSTALLINE SPECIMENS OF Mo AND Ag BOMBARDED BY ELECTRONS

KRUTKIY, V. A., POP, S. S. and ZAPESOCHNYY, I. P., Uzhgorod State
University

[Abstract] A study is presented of the surface glow spectra of single
crystals and polycrystals of Mo and Ta, as well as a polycrystalline
specimen of Ag, bombarded by electrons with energies of $E = 20-1,000$ eV.
Refractory metals were selected as the targets because they can be heated
to high temperatures for purposes of maximum surface cleaning. The
studies were done at an installation using zeolite and magnetic-discharge
pumps rather than oil pumps. Analysis of the results indicates that the
primary contribution to the surface radiation of silver is that of radia-
tion decay of plasmons excited by inelastic scattering of electrons. The
results agree with the predictions of the theory of plasma resonance.
However, some of the data do not completely agree with this theory.
Unexpectedly, for molybdenum and tantalum there were no changes in the dis-
tributions of intensity as the specimens were heated and the surfaces thus
cleaned. This is attributed to the extra cleanness of the surface due to
the lack of oil pumps in the installation. Figures 3; references 21:
9 Russian, 12 Western.

STRUCTURE OF FILMS AND THE ELECTRON STATE OF BaO MOLECULES IN SUBMONOLAYER
COATINGS ON THE (110) FACE OF W

GORODETSKIY, D. A., MEL'NIK, YU. P., and SKLYAR, V. K., Kiev State University
imeni T. G. Shevchenko

[Abstract] The system (110) W-BaO was studied by the diffraction of slow
electrons, Auger electron spectroscopy and the contact potential difference
method of Anderson. The Auger electron spectroscopic data can be used, with
good reliability, to determine the relative coverage in the adsorbed film.
In a monomolecular layer of barium oxide on the (110) surface of W, the
following structures are formed in sequence: (4X3), with a nonprimitive
cell and displaced central molecule, c(1X3), c(1X7/3) and c(1X5/3). As
the degree of coverage increases, the lattice is gradually compressed and
the geometry of the diffraction pattern changes accordingly. The displace-
ment of additional reflexes stops after formation of the last mentioned
structure. The nature of the minimum of the work function during adsorp-
tion of polar molecules of barium oxide is analyzed. It is found that the
formation of the minimum and the maximum on the curve of $\phi = f(n)$ during
adsorption of BaO results only from a change in the density of surface
molecules, not from the influence of the depolarization effect. Figures 2;
references 19: 8 Russian, 11 Western.

PECULIARITIES OF PLASMA REFLECTION IN P-TYPE AND N-TYPE GALLIUM ARSENIDE

KLOTYN'SH, E. E. and PETROV, V. K., Power Engineering Physics Institute,
Academy of Sciences LatvSSR

[Abstract] An investigation is made of the influence that the kind of sur-
face treatment with different crystallographic orientations has on the
shape, position and depth of the plasma minimum of reflected infrared
radiation of heavily doped n-type and p-type gallium arsenide. The speci-
mens had charge carrier concentrations of $10^{16}-10^{20}$ cm^{-3}, and the surfaces
of the plates had orientations of (111) or ($\overline{111}$). Surface treatment was by

mechanical grinding with M2 , M10 and M5 silicon carbide micropowders on a
glass disk, by mechanical polishing with AM5-5 paste on a metal disk with a
double layer of cambric, by chemical-mechanical polishing in a solution of
1 ml of NH_4OH and 700 ml of H_2O, and by chemical etching in a solution of
$H_2SO_4 + H_2O_2 + H_2O = 5 + 1 + 1$. The reflectivities were measured on the UR-20
spectrophotometer. It was found that mechanical treatment forms a surface
layer with properties different from the bulk of the specimen.
This leads to a shift in the plasma minima in the spectral dependence of
the reflectivity into the region of longer wavelengths because the nature of
the plasma minima. The physical factor that influences the shift is the
change in the dielectric function of the material in the region near the
surface. References 2. Illustrations 4.

PROPAGATION OF A VOLTAGE WAVE IN A LINE WITH MAGNETIC INSULATION

VASILENKO, O. I., USSR Academy of Sciences Physics Institute imeni
P. N. Lebedev, Moscow

[Abstract] Transmission lines magnetically insulated by means of a vacuum
gap and having a cathode which functions under conditions of explosive
emission are attractive from the viewpoint of transmitting high-power
energy flux. The magnitude of the electric field in these lines can be
substantially greater than its maximum in traditional lines with dielectrics
as insulators. A study is made here of a plane line charged with a uniform
magnetic field, for the particular case when the source of this field is
the magnetizing current flowing through the line's electrodes. When a
generator is turned on at one end of the line, voltage begins to be estab-
lished, and the propagation of its front is accompanied by the explosion
of cathode inhomogeneities, the formation of a plasma near the cathode, and
the emission of electrons. The characteristics of the electron flux formed
in the line are governed to a considerable extent by the magnitude of the
magnetizing current. If the magnetizing current is not too high, the major
part of the line functions in the magnetic insulation mode, and this
insulation is disturbed only at the electron flux front and is accompanied
by losses. The assumption is made that the rate of propagation of the
signal is constant. Dependences are found of the line's integral character-
istics on two external parameters--the anode voltage and magnetizing cur-
rent. A study is made of the steady-state magnetic insulation mode, on
the basis of equations describing the steady-state electron flux in a
single-flow hydrodynamics approximation. Also studied are the velocity of
the electron flux front, and losses in the line. It is demonstrated that
lossless lines are possible. If the magnitude of the magnetizing current
is greater than a certain critical value, lossless operation is possible
with any anode voltage. Figures 3; references 10: 5 Russian, 5 Western.

USE OF ANALYTICAL EXPRESSIONS FOR CALCULATING THE CHARACTERISTICS OF HEAT
AND MASS TRANSFER DURING LAMINAR FLOW OF A MIXTURE NOT IN CHEMICAL EQUILIB-
RIUM THROUGH A PIPE WITH BOUNDARY CONDITIONS OF THE SECOND KIND

MISHINA, L. V., NESTERENKO, V. B., SEREBRYANYY, G. Z., TVERKOVKIN, B. YE.
and TUSHIN, N. N., Institute of Nuclear Power Engineering, Academy of
Sciences of the Belorussian SSR

[Abstract] Heat and mass transfer during laminar flow through a pipe is
considered in the case of a mixture not in chemical equilibrium during a
reaction of arbitrary stoichiometry. The calculations are based on the
conventional system of differential equations in cylindrical coordinates
and in dimensionless form, with boundary conditions of the second kind.
Two auxiliary functions are introduced which reduce the problem to a
Bessel equation and a Sturm-Liouville problem. They characterize the sur-
face temperature of the pipe wall and the reactivity of the gas in terms of
thermophysical properties. The solution is sought in the form of Fourier
series, with the reactivity parameter averaged according to a special pro-
cedure involving the use of the enthalpy-temperature diagram. Typical
numerical results are shown, namely temperature profiles along the pipe
calculated from the general system of differential equations by this
method and calculated assuming a Poiseuille velocity profile respectively.
Figures 1; tables 3; references 10: 5 Russian, 5 Western.

THEORETICAL STUDY OF THE KINETICS OF ELEMENTARY PROCESSES IN XENON IN
FRONT OF A SHOCK WAVE

VASIL'YEV, M. G., ZHIKHAREVA, T. V., TUMAKAYEV, G. K., Institute of Physics
and Technology imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] A study is presented of the kinetics of excitation and ioniza-
tion of xenon atoms, as well as the kinetics of heating of an electron gas
in front of a shock wave. The theoretical investigation establishes that
the kinetics of ionization of xenon atoms differs qualitatively from the
kinetics of ionization of argon and mercury vapor. The process of photo-
ionization and the process of associative ionization must both be considered,

the process of photoionization becoming the predominant process in the
formation of charged particles as the intensity of the incident shock wave
increases. In contrast to ionization kinetics, the kinetics of excitation
of xenon and argon are the same. The significance of electron-atom colli-
sions in the population of resonant levels and the kinetics of heating of
the electron gas is significant in the area immediately adjacent to the
leading edge of the shock wave. Figures 7; references 27: 13 Russian,
14 Western.

CALCULATION OF SUBSONIC FLOWS OF VISCOUS GAS IN FLAT CHANNELS AND IN WAKES

BYRKIN, A. P. and SHCHENNIKOV, V. V., Moscow

[Abstract] Most now published studies on flows of viscous compressible
gas in channels (nozzles) are based on a known model of flows: separation
of flow into a boundary layer and an inviscid core. This model has been
proven to satisfactorily describe the actual phenomenon. In recent years
aerodynamic devices have appeared in which flows are formed with rather
low Reynolds numbers (300 to 500). The authors consider the problem of
laminar flow of a viscous gas in channels of fixed cross section and
finite length that are formed by a cascade of plates, and also in the wakes
behind the plates. The analysis is based on complete Navier-Stokes equa-
tions. An investigation is made of the case of subsonic flow of the gas
when a direct compression shock is located at the channel inlet. The cal-
culations are done for Reynolds numbers of 20-300. The wall temperature
was taken as equal to the stagnation temperature. The results of the cal-
culations confirm the pattern of viscous gas flow in long channels found
in approximate solution of the problem. Figures 4; references 7: 6 Russian,
1 Western.

TURBULENT FLOW AND HEAT TRANSFER CALCULATIONS FOR HEATED PIPES WITH
SINGLE-PHASE COOLANTS IN A NEAR-CRITICAL STATE

PETUKHOV, B. S. and MEDVETSKAYA, N. V., Institute of High Temperatures,
USSR Academy of Sciences

[Abstract] A mathematical model of turbulence in heated vertical water and
air pipes has been proposed earlier which takes into account the effects of
thermogravity and thermal acceleration on turbulent heat and mass transfer
under near-atmospheric pressures. Here this model is used for calculating
the parameters of turbulent heat and mass transfer in heated pipes carrying
water or carbon dioxide in a supercritical state. It is a system of
differential equations describing the boundary layer of an incompressible
fluid with variable physical properties and a negligible dissipation of
energy. The results are presented in the form of axial profiles of velocity,
wall temperature, Nusselt number and the frictional drag coefficient, also
radial profiles of velocity and the momentum exchange coefficient. These
data are compared with calculations and some measurements made by other
authors. Figures 11; tables 1; references 25: 15 Russian, 1 German,
9 Western.

GENERATION OF COHERENT RADIATION IN THE NEIGHBORHOOD OF CYCLOTRON RESONANCE

BAYER, V. N. and MIL'SHTEYN, A. I., Novosibirsk, Institute of Nuclear
Physics, Siberian Affiliate of the USSR Academy of Sciences

[Abstract] In recent years major advances have been scored in the generation
of coherent radiation by a beam of electrons passing through a magnetic
lattice (the free-electron laser), as based on the automodulation of elec-
tron phase distribution in the process of the interaction between the elec-
tron beam and the electromagnetic wave in the magnetic lattice. In this
paper attention is drawn to an analogous effect occurring in the inter-
action between a beam of electron traveling a helical path in a magnetic
field and an electromagnetic wave propagating along the magnetic field in
the neighborhood of cyclotron resonance. Corresponding formulas are derived
with emphasis on the currently most interesting case of the variation in
both longitudinal and transverse pulses when the electron-wave interaction
period is shorter than the pulse duration itself. The findings demonstrate
that a sufficiently large amplification factor can be achieved for relati-
vistic particles with large entrance angles. This is promising since in
recent years attempts have been made to develop lasers utilizing relativis-
tic electrons as based on the use of systems with recuperation such as the
"Epokha" system (electron density ($N/V = 10^8$ cm^{-3}, energy 100 keV, current
1A) applied in the electron cooling system at Novosibirsk (in a magnetic
field of H = 3.5×10^6 A/m oersted, at entrance angles of 50-60°, with
resonance wavelength of the order of 2 mm). Figures 2; references 11:
7 Russian, 5 Western.

AN EXPERIMENTAL STUDY OF BEAM COLLAPSE WITH SELF-FOCUSING IN A
NONLINEAR MEDIUM

ASKAR'YAN, G. A. and MUKHAMADZHANOV, M. A., Physics Institute imeni
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[Abstract] In the presence of self-focusing (self-stressing of a powerful
beam in a nonlinear Kerr medium) foci may form whose dimensions depend on

the properties of the medium and the dynamics and dimensions of the beam. The nature of the collapse of the field $E \sim 1/|z-z_{foc}|^a$ is here experimentally investigated for the first time on the basis of photometric measurements of the absolute density of energy distribution during beaming. The experiment was conducted with the aid of the beam of a single-mode single-frequency ruby laser with power up to 150 kW with a pulse time half-width of 10 ns. A beam with a profile extremely close to gaussian was focused by means of a lens onto the free surface of a linear medium (incomplete filling of a vertically aligned cuvette). The nonlinear medium used was nitrobenzene. The initial diffraction divergence resulted in the self-focusing of the unfocused beam. On the basis of these experiments the effective beam collapse factor is determined for the first time and shown to be close to 2/3 in most cases. The minimum size of the beam at the focus is considerably smaller than the estimate given by the drop in absolute energy density by a factor of e. The length of the focus is many times greater than the Fresnel length which demonstrates that the observed focus is a segment of a waveguide whose length is a function of the relaxation of nonlinearity, i.e. of the path traveled by the focus during relaxation time $\ell \approx \nu_{foc}\tau_{rel}$ where $\tau_{rel} = 5 \cdot 10^{-11}$ sec for nitrobenzene. Figure 1; references 15: 12 Russian, 3 Western.

AN OPTICAL-WAVEGUIDE AMMONIA LASER WITH A RASTER PUMPING SYSTEM

VASIL'YEV, B. I., GRASYUK, A. L., YEFIMOVSKIY, S. V., SMIRNOV, V. G. and YASTREBKOV, A. B., Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] A study was made of an NH_3-laser with pumping from a pulsed CO_2-laser through a combination of an optical waveguide and a focusing raster system. Its performance was measured, namely the dependence of the emission energy on the partial pressures of NH_3 and buffer N_2 in the mixture. A maximum energy of 0.35 J was obtained under pressures $p_{NH_3} = 1.2$ mm Hg and $p_{N_2} = 200$ mm Hg with a 5x5 mm^2 waveguide cross section, but less energy under higher p_{NH_3} pressure and lower p_{N_2} pressures with larger waveguide cross sections. An efficiency of 10% was reached and emission cutoff occurred only at p_{N_2} pressures within 400-500 mm Hg, indicating that air can be used as the buffer gas. Figures 2; references 9: 3 Russian, 6 Western.

THEORY OF A TRAVELING-WAVE ZEEMAN GAS LASER WITH HIGH RADIATION INTENSITY

SAVEL'YEV, I. I.

[Abstract] The theory of a traveling-wave Zeeman gas laser is considered
without the weak-field approximation, this approximation making the method
of perturbations applicable but limiting the validity to near-threshold
emission levels only. The constraint is lifted and, accordingly, single-
mode emission in a ring laser with a circularly anisotropic resonator
cavity and with circularly polarized opposing waves is analyzed, assuming a
longitudinal magnetic field. The equations of the density matrix are
solved in Fourier series of space harmonics and an expression is derived
for the polarization, with which the steady-state intensity of traveling
waves and the frequency of Zeeman beats can be calculated. The author
thanks A. M. Khromykh for the helpful discussion of problems encountered in
this study. References 9: 6 Russian, 3 Western.

TRANSIENT STRUCTURE OF EMISSION FROM AN ARGON LASER DURING PASSIVE MODE
LOCKING

VINOGRADOVA, A. A., KRINDACH, D. P. and NAZAROV, B. I., Moscow State
University imeni M. V. Lomonosov

[Abstract] Argon lasers with locking of longitudinal modes are used in
many applications, especially for synchronous pumping of dye lasers. Lock-
ing can be achieved not only by active means with an optoacoustic modulator
but also by passive means with an intracavity absorbing element. Here the
transient structure of emission is analyzed, namely the order and the
regularity of pulse repetition, the duration and the shape of pulses, the
shape of the pulse envelope, and the interval between pulses. The structure
is found to depend more on the ratio of unsaturated amplification to absorp-
tion than on the location of the absorber inside the resonator cavity. In
terms of emission characteristics, passive mode locking can be almost as
effective as active mode locking and this has been confirmed experimentally.
The authors thank V. M. Salimov and M. I. Landman for the helpful suggestions
and comments concerning some of the problems, also A. K. Romanyuk for helping
with the measurements. Figures 3; references 11: 6 Russian, 5 Western.

A DIRECTIONAL COUPLER FOR LASER BEAMS USING A DIFFRACTIONAL PHASE GRATING

APOLLONOV, V. V., BOCHKAR', YE. P., ZASLAVSKIY, V. YA. and KHOMICH, V. YU.,
Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow

[Abstract] The use of a diffraction grating as a directional coupler for
laser beams is considered, as means to facilitate either simultaneous or
sequential measurements of several laser parameters. A specular phase grat-
ing is most suitable for the high levels of laser radiation power. Here
diffraction at such a grating is examined, a sinusoidal profile being
simplest to analyze and yielding a better performance but a meander profile
being simplest to analyze and yielding a better performance but a meander
profile being technologically easier to produce. The grating design parame-
ters are established, including the cooling requirements, and their
inspection with a CO_2-laser is described. References 7: 3 Russian, 4 Western.

A SCANNING SEMICONDUCTOR LASER WITH TRANSVERSE PUMPING BY AN ELECTRON BEAM

NASIBOV, A. S., PECHENOV, A. N., POPOV, YU. M., RESHETOV, V. I. and
SKASYRSKIY, YA. K., Institute of Physics imeni P. N. Lebedev, USSR Academy
of Sciences, Moscow

[Abstract] Lowering the emission threshold in a scanning laser with
electron-beam pumping under lower acceleration voltages is feasible with
transverse rather than longitudinal pumping, but then only one-dimensional
scanning is possible and 2-dimensional scanning requires an additional beam
deflection. In this study lamellar CdS and CdS-CdSe crystals were trans-
versely excited by a sharply focused 40 keV electron beam, for a scanning
rate of $5 \cdot 10^5$ cm/s and a pulse repetition rate variable from 40 Hz to 16
kHz. The minimum current threshold was 1 A/cm^2 and, with the nonradiative
losses in the broken down layer reduced, a maximum emission power of 1.2 W
at an efficiency of 5% could be attained. The authors thank S. A. Pendyur
for supplying the specimens. Figures 2; references: 6 Russian.

MEASUREMENT OF THE PUMPING RATE AND OF THE ELECTRON CONCENTRATION IN PULSED
He-Eu AND He-Sr LASERS

KLIMKIN, V. M., PROKOP'YEV, V. YE. and FADIN, L. V.

[Abstract] Measurements were made of the pumping rate of upper levels and
also of the electron concentration in an He-Eu laser operating with excita-
tion by microsecond current pulses and in an He-Sr laser operating with dis-
charge afterglow, both lasers being characterized by a high output power and
a high efficiency. Measurements of the pumping rate were based on the rela-
tive change in the intensity of unreabsorbed spectral lines along the
radius and along the axis of the discharge tube, as a result of emission,
and on a calorimetric determination of the emission power. Under nearly
optimum conditions the pumping rate was found to be $(0.6 \pm 0.3) \cdot 10^{20}$ and
$(1.5 \pm 0.5) \cdot 10^{20}$ $cm^{-3}s^{-1}$ and the electron concentration was found to be
$1.5 \cdot 10^{14}$ and $3 \cdot 10^{14}$ cm^{-3} respectively. Figures 3; tables 1; references:
3 Russian.

EFFECT OF NITRIC OXIDE ADMIXTURES ON ENERGY AND SPECTRAL CHARACTERISTICS OF
AN ELECTRON-BEAM CONTROLLED CO-LASER

SUCHKOV, A. F. and SHEBEKO, YU. N., Institute of Physics imeni P. N. Lebedev,
USSR Academy of Sciences, Moscow

[Abstract] The effect of small No admixtures on the characteristics of an
electron-beam controlled Co-laser is analyzed theoretically, with the five
most significant processes taken into account: vibrational-vibrational (VV-)
exchange, vibrational (VT-) relaxation, excitation of vibrational levels by
electron impact, spontaneous and induced emission.   Calculations are
based on the equations for a binary mixture of diatomic molecules, with the
NO content varied from 0.1 to 1.3%, assuming that vibrational exchange
depends on both short-range and long-range interaction. The distributions
of NO and CO molecules with respect to vibrational levels and the gain on
vibrational-rotational transitions in NO and CO molecules at 100 and 300 K
temperatures are calculated for several instants of time during the pumping
period (50 μs) and after. Estimates of the emission power, at an energy

density of 0.3 J/cm^3, and of the fraction of emission power due to NO indicate that such small additions of NO become effective only during long-duration pumping pulses, after CO molecules have had time to impart a large part of their vibrational energy to NO molecules. A small NO admixture thus does not appreciably affect the energy characteristics of a CO-laser, although it appreciably alters the spectrum. The authors thank B. K. Urin for helpfully commenting on the results of this study, also V. I. Dolinina and V. D. Kozlov for the help in carrying out the computer calculations. Figures 6; tables 1; references 14: 6 Russian, 8 Western.

MEASUREMENT OF THE ABSOLUTE ACCELERATION DUE TO GRAVITY WITH A BALLISTIC LASER GRAVIMETER

ARNAUTOV, G. P., KALISH, YE. N., KUKULIN, F. I., KOSHKOVICH, V. P.,
LOKHMATOV, A. I., MALYSHEV, I. S., NESTERIKHIN, YU. YE. PETRASHEVICH, L. A.,
SMIRNOV, M. G., STUS', YU. F. and TARASYUK, V. G., Institute of Automatic
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Novosibirsk

[Abstract] An instrument has been built for determining the absolute acceleration due to gravity. It consists of a ballistic chamber which allows for free motion of a falling body through a total distance of 1 m, a laser interferometer with the laser stabilized with respect to the Lamb shift and a control laser stabilized with respect to an iodine absorption cell, also an electronic counter connected to a minicomputer. The operating principle of this instrument is measuring the time of fall from some point through two different lengths of the path. Random errors are due to count discretization and microseismic pedestal vibrations. Systematic errors are in the instrument mounting, the laser beam collimation and the laser wavelength identification, in the time measurement, also due to tidal fluctuations of the force of gravity as well as to the gradient of this force and to the presence of other acting forces. Actual measurements have been made in Moscow, Potsdam, Sevres and Singapore over the 1975-1977 period, with the absolute total rms error eventually reduced to within ±0.015 mgal (15·10^{-8} m/s^2). Figures 3; tables 6; references 6: 3 Russian, 3 Western.

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SPECTROSCOPIC ANALYSIS OF A LASER ON A CF_4-MOLECULE WITH OPTICAL PUMPING

ALIMPIYEV, S. S., BARONOV, G. S., KARLOV, N. V., KARCHEVSKIY, A. I.,
MARTSYNK'YAN, V. L., NABIYEV, SH. SH., SARTAKOV, B. G. and KHOKHLOV, E. M.,
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[Abstract] A study of a CF_4-laser was made to determine its frequency
spectrum and the feasibility of smooth frequency tuning. It was pumped from
an atmospheric CO_2-laser and its resonator cavity was formed by a diffrac-
tion grating with 150 lines/mm, a plane-parallel germanium plate, a pair of
KBr prisms, a rotatable mirror and an opaque mirror. The rotational emis-
sion lines could be identified and the dependence of the emission frequency
on the pumping frequency established, also the spectra of linear absorption
in the $\nu_2 + \nu_4$ band and in the ν_4-band were measured. The number of emis-
sion frequencies within the 615-646 cm^{-1} was increased substantially by using
isotopically substituted molecules CO_2^{18} and $C^{13}F$. The emission frequencies
can be located on pairs of straight lines intersecting at points which
correspond to the Q-bands of these absorption bands. Figures 5; references
8: 4 Russian, 4 Western.

NUMERICAL ANALYSIS OF A CHEMICAL HF+HCl LASER BASED ON THE CHAIN REACTION
BETWEEN ClF AND H_2

ITOSHIN, V. I., Institute of Physics imeni P. N. Lebedev, USSR Academy of
Sciences, Moscow

[Abstract] A kinetic model of a laser based on the chain reaction between
ClF and H_2 is constructed and the performance characteristics of such a
laser over a wide range of input conditions are analyzed numerically. The
mechanism of this reaction is a complex one consisting of parallel and
sequential processes, namely the trigger reaction $Cl \rightarrow Cl + F$ followed by
four chains through respective atoms and breakup of chains. There also
occur vibrational-translational and vibrational-vibrational relaxation pro-
cesses. Estimates of the energy of stimulated emission, depending on the

chemical composition and on the pressure of the mixture as well as on the concentration of active centers and on the emission spectrum, indicate that low hydrogen concentrations on the HF side ($H_2:ClF < 1$) and high hydrogen concentrations on the HCl side ($H_2:ClF > 1$) yield the maximum energy output. In an HF+HCl mixture, moreover, the reaction $H+ClF \rightarrow HCl+?$ is found to be the major factor contributing to emission, while the reaction $H+Cl_2 \rightarrow HCl+Cl$ contributes insignificantly but compensates the detrimental effect of the reaction $Cl+H_2 \rightarrow HCl+H$. The latter reaction on the one hand produces unexcited HCl-molecules reducing the emission power and on the other hand produces H-atoms necessary for faster excitation of HCl-molecules. The reaction $Cl+ClF \rightleftharpoons Cl_2+F$ contributes to a delay of emission cutoff. According-ing to the data, the $ClF+H_2$ system yields 20-30 times more power than the H_2+Cl_2 system as a source of laser radiation on HCl but approximately three times less power than the H_2+F_2 system as a source of laser radiation on HF. The author thanks A. S. Pr.... for the support and valuable comments. Figures 3; tables 6; references ... 20 Russian, 15 Western.

NONLINEAR NONRECIPROCAL EFFECTS IN A RING LASER IN A LONGITUDINAL MAGNETIC FIELD

ANDRONOVA, I. A., KOVALITA, Zh. A. and MURAYEV, Yu. A., Institute of Applied Physics, USSR Academy of Sciences, Gorkiy

[Abstract] Nonreciprocal effects in a ring laser caused by application of a longitudinal magnetic field and dependent on the excess over the emission threshold are analyzed from the standpoint of laser gyroscopy and nonlinear laser spectroscopy. The analysis is based on equations of a lumped-parameter model. Both the frequency difference and the intensity difference between opposing waves are calculated for a single-isotope gas and for an equi(50%)-isotope gas mixture as the active medium. Numerical estimates of these nonlinear nonreciprocal effects are shown and compared with linear effects characterizing a gas laser at the wavelengths $\lambda = 0.63$ and 1.15μ m. The authors thank V. L. Jeremian for reviewing the manuscript and offering valuable comments. Tables 2; references 16: 11 Russian, 5 Western.

A PULSED Pb-LASER AT THE λ = 722.9 nm WAVELENGTH WITH TWO GAS-DISCHARGE TUBES

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Design Office for Scientific Instruments, Siberian Division of the USSR
Academy of Sciences, Tomsk

[Abstract] In order to improve the energy characteristics of pulsed lasers
on self-limiting transitions, it is necessary to increase the electric field
intensity in the active medium or increase the length of the gas-discharge
gap. Here an experimental study of a Pb(vapor)-Ne laser emitting at the
λ = 722.9 nm wavelength in the self-heating mode was made, with two differ-
ent rather than identical gas-discharge tubes having three electrodes and a
ZrO_2 thermal insulation layer each. Both tubes could be energized together
either in a single-loop or in a split 2-loop configuration. The concentra-
tion threshold was found to be lower while the efficiency and the average
specific power output were found to be higher in the second case. A record
high average power of 3.2 W was obtained with a discharge volume of 630 cm^3.
Figures 4; tables 1; references 3: 1 Russian, 2 Western.

NONSTEADY INTRACAVITY GENERATION OF THE OPTICAL SECOND HARMONIC IN
LASERS WITH ACTIVELY NONLINEAR MEDIA

KARPENKO, S. G. and STRIZHEVSKIY, V. L., Kiev State University imeni
T. G. Shevchenko

[Abstract] Generation of gigantic second-harmonic pulses in a laser with an
actively nonlinear medium such as lithium niobate activated by neodymium ions
is analyzed theoretically, taking into account the effect on fundamental-mode
generation. The appropriate equations describing nonlinear frequency con-
version are formulated and solved, accordingly, in the approximation of a
transversely uniform and linearly polarized field with partially transmitting
plane mirrors in the resonator cavity. Emission transients have been calcu-
lated numerically, on this basis, for the cases of passive and active Q-
switching. The results indicate an optimum degree of nonlinearity which
corresponds to maximum emission efficiency and a limiting degree of non-
linearity which corresponds to emission cutoff. Figures 5; references 8:
5 Russian, 3 Western.

EFFECT OF SPATIAL NONLINEARITY DISPERSION ON LASER RADIATION SELF-FOCUSING
IN LIQUID CRYSTALS: THEORY AND NUMERICAL EXPERIMENT

ARAKELYAN, S. M., VARDANYAN, G. A., VYSLOUKH, V. A., LYAKHOV, G. A.,
MAKAROV, V. A. and CHILINGARYAN, YU. S., Yerevan State University

[Abstract] The nonlinearity and the nonlinearity relaxation time are much
more significant in liquid crystals than in ordinary liquids, especially near
the isotropic-to-nematic transition temperature. Here the threshold condi-
tions for self-focusing of laser radiation in liquid crystals are established
analytically, in the anaberrational approximation, also the changes in both
intensity and width of a light beam in the isotropic phase are determined.
Calculations are based on the parabolic equation of nonlinear diffraction,
with a nonlinear field dependence of the orientational order parameter.
Stabilization of the minimum beam radius is found to be attributable to
opposing actions of the Kerr mechanism and the spatial nonlinearity disper-
sion mechanisms. Self-focusing is, furthermore, examined on the basis of a
numerical experiment which yields the critical conditions. When the thermal
mechanism of spatial nonlinearity dispersion predominates, in fact, then
self-focusing is governed by the Kerr mechanism as well as by linear diffrac-
tion and defocusing due to a rise in ambient temperature. Near the critical
temperature, moreover, the relaxation time for the order parameter becomes
strongly temperature dependent and its spatial dispersion becomes more
appreciable. The authors thank S. A. Akhmanov for the helpful comments.
Figures 5; references 17: 9 Russian, 8 Western.

EFFECT OF NONRECIPROCAL ELEMENTS ON THE INTERACTION BETWEEN ELLIPTICALLY
POLARIZED OPPOSING WAVES IN A GAS RING LASER

TIMOV, YE. A., Leningrad State University

[Abstract] Nonlinear interaction between elliptically polarized opposing
waves in gas ring lasers, normally emitting two quasi-orthogonal pairs of
opposing waves, is considered under conditions where arbitrary nonreciprocal
elements on the frequency difference or nonreciprocity between opposing

waves is determined in the case of single-mode emission. Estimates for a laser on a 50% gaseous isotope mixture and nonreciprocal elements of the Faraday kind in the cavity indicate that the difference between losses associated with the respective waves and the difference between the corresponding natural frequencies of the cavity contribute negligibly to the nonlinear frequency difference proportional to the emission intensity. However, the polarization difference between the two waves results in differences between the ellipticity and the azimuth of each, which in turn give rise to a nonlinear frequency difference proportional to the average allipticity and the ellipticity difference. This is an important factor to consider in high-precision laser gyrometry. The author thanks E. Ye. Fradkin for the interest in this study and the helpful discussion of its results. References: 3 Russian.

INVESTIGATION OF BREAKDOWN OF GASES UNDER THE EFFECT OF CO_2 LASER EMISSION PULSES

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[Abstract] The question of the mechanism for the initiation of the breakdown of gases under the effect of laser emission pulses is an open one. Some ideas are given here regarding a possible mechanism for this process, along with a model. A description and the results are given of an experimental investigation of breakdown thresholds for helium, argon and air under the effect of emission with a wavelength of 10.6 μ m over a wide pressure range. Detailed investigations were made of the breakdown thresholds of these gases as a function of the diameter of the focal spot and the pressure and nature of the gas. The pressure varied from 70 mm Hg to 25 atm. A pulsed CO_2 laser with a transverse discharge was used, operating in the Q-switched mode, with the laser mixture, $CO_2:N_2: He = 1:1:8$, under atmospheric pressure. The results show that both the absolute values of the thresholds and the nature of the dependence of the threshold intensity on pressure depend substantially on the diameter of the focal spot. As the diameter increases the minimum threshold intensity is achieved at a higher pressure. The inverse relationship between the threshold intensity and diameter of the focal spot has been related to the probability of the presence of a particle of certain diameter in the focal space. This theory is discussed in conjunction with the cumulative ionization theory, which employs a time-independent breakdown criterion. It is stressed that what is recorded in experiments directly is not the breakdown thresholds of

gases, but threshold values of the intensity of formation of the laser flash. The laser flash itself is made up of a number of simple stages. The first includes breakdown of the gas, i.e., the development of Townsend ionization and the formation of the initial plasma. Breakdown of the gas takes place at laser emission intensities above a certain threshold. This threshold for filtered air is 10^{10} W/cm^2. The region of developed ionization becomes heavily absorbent and is rapidly transformed into a plasma under high pressure, resulting in the formation of a spherical shock wave in the gas. At the second stage of the process further development of the breakdown plasma depends on the intensity of the laser emission. Intensities on the order of 10^8 W/cm^2 are needed to sustain luminous detonation. What are really measured in experiments in determining the breakdown thresholds of real gases are threshold values of the intensity of the formation of a laser flash, which actually equal thresholds for sustaining luminous detonation in gases. Rayzer's (1974) theory of the limits of luminous detonation is discussed, wherein the existence of a limit is associated with energy losses occasioned by the lateral dispersion of the plasma. The increase in the breakdown plasma after the origin of the shock wave near the surface of a particle is associated with the propagation of a luminous detonation wave. Propagation occurs first in the region of the vapor near the surface of the particle, and then, with laser emission of sufficient intensity to support the luminous detonation wave, this wave can cross over into the gas surrounding the particle. This crossover is represented in this model of the process as the "bottleneck" determining the threshold intensity values recorded in the experiments. The characteristic dimension in this model is not the radius of the focusing spot, but the size of the particle. This interpretation has helped to establish consistency in various prevalent theories on this phenomenon. Figures 5; references 19: 10 Russian, 9 Western.

EXPANDING FUSION PLASMA

GALUSHKIN, L. M., BOBIRKO, L. I. (deceased) and KALININ, A. V., Institute by ..., Academy of Sciences, Moscow

[Abstract] nuclear fusion in combination with concentrated laser regarded as feasible means of producing a positive energy balance. Here conversion of the plasma of the target material to short-wave coherent Calculations and experimental data are shown pertaining and ionization-recombination processes. They

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confirm the feasibility of such a reactor-laser operating within the narrow ultraviolet range of the spectrum with the scattering plasma of the target material used in a fusion reactor. The article was presented by academician A. Ye. Sheyndlin 6 Dec 78. **Figures 1; references: 7 Russian.**

THEORY OF THE INTERACTION OF LASER RADIATION WITH METALS

ANISIMOV, S. I., GAL'BURT, V. A., IVANOV, M. F., POYUROVSKAYA, I. YE. and FISHER, V. I., Institute of Theoretical Physics imeni L. D. Landau, USSR Academy of Sciences, Chernogolovka

[Abstract] A description is presented of a model of the interaction of a high-intensity laser beam with metals under conditions such that the temperature of the metal is raised to above the critical temperature by the action of the laser beam, and some numerical calculations based on the description are presented. Only one-dimensional, nonsteady flows of a dense plasma caused by absorption of the laser radiation are studied. The results of the numerical model are compared with the experimental data. The model described allows analysis of laser experiments in the area of beam intensities around the critical parameters, and can be used to generate information on the thermodynamic properties of metals on the basis of experimental results. **Figures 4; references 26: 22 Russian, 4 Western.**

INVESTIGATION OF THE LASING CHARACTERISTICS OF 1,4-BIS[2,5-DIMETHYLSTYRYL] BENZENE DURING UV EXCITATION BY A NITROGEN LASER

ARARATYAN, YE. A., VARTANYAN, S. A., MELIK-SARKISYAN, A. A., NAZARYAN, A. A. and TORGOMYAN, G. B.

[Abstract] Due to the intensive expansion of the range of applications of tunable dye lasers, the synthesis of new organic compounds which may be used

therein offers great interest: they may be able to enlarge the range of
tuning and quantum yield, improve stability of output parameters, etc.
The most universal source for dye laser excitation, especially in the
violet and near-UV region, is a nitrogen laser. The lasing characteristics
of 1,4-bis[2,5-dimethylstyryl]benzene were investigated and compared with
analogous properties of POPOP laser dye. An Al-201 N$_2$ laser operating at
a wavelength of 337.1 nanometers was used for the experiments; a pulse 8
ns in length had a 5 cm focal length. In contrast to POPOP dye which con-
tains a heterocyclic compound, the xylyl has more resistance to radiation
and thermal exposure. Measurements were made of the spectral characteris-
tics of the two dyes: it was found that xylyl conversion efficiency is
somewhat greater than POPOP: thus it may be successfully used as a working
medium in tunable lasers. Figures 2; references: 5 Russian.

AVER'YANOV, N. Yu. and BALTSHIN, YU. A.

[Abstract] Energy and time characteristics have been studied for molecular
lasers with active mixture pressures up to atmospheric or high levels.
According to the model employed, which was developed for lasers with low
active mixture pressure, the basic kinetic equations describing the dynam-
ics of populations of carbon dioxide molecules in a high pressure laser are
not written for discrete levels, but for energies stored in each type of
oscillation: rate constants of the primary processes of excitation and
deexcitation of molecules, relaxation time of different channels of relaxa-
tion, and the distribution function of electrons will have a different
relationship as a function of partial gas pressures. Earlier equations
were used to compute characteristics of lasing pulses of TEA CO$_2$ lasers
operating under conditions of a semi-self-maintained discharge with
preionization of the main volume by UV emission. A new model had to be
developed for such high pressure lasers. Helium was found to be the main
"buffer" of photoelectrons, in spite of the highest ionization potential:
addition of nitrogen shapes a UV spectrum optimum for photoionization of
helium. During the lasing molecule and also absorbs UV emission. Consid-
eration of ... ionization makes the theoretical concept more
... with experiment. Figures 3; references 9: 2 Russian,
7 English.

DETERMINATION OF POPULATIONS OF VIBRATIONAL LEVELS OF CARBON DIOXIDE
MOLECULES IN GAS DYNAMIC LASERS BY IR SPECTROSCOPY

BAKHIR, L. P. and OVERCHENKO, YU. V.

[Abstract] The absorption and emission spectra of some vibrational and
rotational transitions of the carbon dioxide molecule in the range of 4.3,
10, and 15 μ m are analyzed under non-equilibrium conditions at the outlet
of a gas-dynamic laser; and an examination is made of the possibility of
their use to determine the populations of lower vibrational levels of
carbon dioxide at different degrees of expansion. In view of the sharp
distinction of relaxation rates for various degrees of freedom in a gas-
dynamic laser, the vibrational temperatures of various levels of CO_2
may differ significantly from each other, as well as from rotational and
translational temperatures. In describing populations in terms of the
length of a jet, vibrational and rotational energies are separated and
population temperatures equal to mode temperatures are assumed for purely
symmetric deformation and asymmetric vibrations. A method for determining
the absolute populations of low vibrational levels of the carbon dioxide
molecule is developed according to measurements of absorption and bright-
ness of a non-equilibrium jet near given frequencies. Figures 4; refer-
ences 17: 7 Russian, 10 Western.

EFFECT OF LASER RADIATION (10.6 μ m) ON CRYOGENIC GLOW DISCHARGE IN HELIUM

ASINOVSKIY, E. I., KIRILLIN, A. V. and KHODAKOV, K. A., Institute of High
Temperatures, USSR Academy of Sciences

[Abstract] The mechanism of the response of glow discharge to laser radia-
tion was studied with a cryogenic steady discharge in helium and infrared
radiation (λ = 10.6 μ m) from a CO_2 laser generating pulses of 1 J energy
and 250 ns duration. The discharge tube contained an NACl window, a
cylindrical hollow cathode and a plane anode, two point probes and one
ring probe. A radiation detector and an oscillograph were used for
measurements. Noteworthy was that a drop of the helium pressure to 47 Pa
resulted in a buildup of a high-voltage discharge with a distinctive

electron beam, but only with the discharge tube cooled by means of liquid nitrogen. Figures 3; references 6: 3 Russian, 5 Western.

DISCHARGE IN AN ELECTRON-BEAM CONTROLLED LASER OPERATING IN THE PULSE-FREQUENCY MODE WITH A HIGH DUTY FACTOR

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[Abstract] An experimental study was made of discharge and emission pulses in a CO_2 laser operating in the pulse-frequency mode with a CO_2:N:He = 1:9:5 mixture under atmospheric pressure. The electron gun generated 120 keV electron beams with current pulses, the current density at the anode of the discharge tube was $200 \mu A/cm^2$, and the duration of pulses could be regulated smoothly over the $5 \cdot 10^{-6}-10^{-3}$ s range at frequencies from 10 to 250 Hz. Here the pulse shape and the conditions of emission stability are established on the basis of an approximate theoretical analysis involving differential equations of pumping and of gas dynamics. Accordingly, the duration of emission pulse necessary to avoid instability is calculated in the case of thermal "cutoff" with either slow or fast heating. The transient time is calculated on the assumption of a constant temperature. The results agree closely with experimental data, they can also be useful for calculating the emission intensity under quasi-steady conditions and for optimizing the design of a process laser with respect to performance trade-offs as well as reliability and cost. The authors thank A. S. Myasnikov of the analytical comments and T. V. Grigor'yev for designing the electron gun. Figures 6; references 11: 8 Russian, 3 Western.

STIMULATED EMISSION AND PHOTOISOMER TRANSFORMATIONS IN POLYMETHINE DYES

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[Abstract] Using a number of benzoindolinin dyes that have a quantum yield
of 15-25%, the authors study the process of formation of long-lived stereo-
isomers that influence the lasing threshold in solvents of different vis-
cosity (Q-switched ruby laser with longitudinal pumping). Shown in the
diagram is the general formula of the series of dyes, differing only in the
radical Y introduced into the polymethine chain: 1--H; 2--C_6H_5; 3--Cl;
4--CH_3; 5--$O(CH_2)_2OH$.
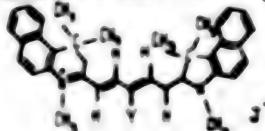
Although the spectral-luminescence characteristics of these dyes are fairly
close, their lasing capacity differs greatly. Dyes No 1 and 2 are efficient
lasers over a wide range of optical densities (d=2-10) in low-viscosity
solvents, dye No 3 shows stimulated emission only at high density (d of 10
or more) and in a narrow density range, while dyes No 4 and 5 do not show
lasing action under the same conditions. Dye No 5 is capable of lasing only
in a cavity with one mirror having a reflectivity of more than 30%, and the
other--99.5%, and density of d = 15 or more with threshold exceeding
20 MW/cm^2. When a viscous medium (glycerin) is used as the solvent, all
dyes show lasing action with threshold intensity of 1 MW/cm^2 or less, and
efficiency up to 20-25%. On the basis of these results and an analysis of
oscillograms of dye transmission, a model is proposed for the transitions
in the molecules of the investigated dyes that undergo photoisomer transfor-
mations. It is concluded that the lasing capacity of dye molecules is
decisively influenced by the formation of long-lived isomers with an absorp-
tion band that overlaps the fluorescence band and results in induced losses
on lasing frequencies. Figures 6; references 13: 10 Russian, 3 Western.

UDC 621.373.8.029.71

GASDYNAMIC PERTURBATIONS OF THE FLOW IN PULSE-PERIODIC CO2 LASERS.
I.   CONVECTIVE REMOVAL OF THE HEATED GAS FROM THE DISCHARGE REGION

BARANOV, V. YU., NIZ'YEV, V. G. and PIGUL'SKIY, S. V.

[Abstract] The authors study the gasdynamic phenomena that take place in pulse-periodic lasers, and their influence on limitation of pulse recurrence frequency. The experiments were done on a facility with closed-cycle gas pumping with nitrogen, carbon dioxide and a laser mixture of $CO_2:N_2:He = 2:2:3$. The gas flowrate in the discharge region was 4 m/s, and a system with ultraviolet pre-ionization was used. To determine gas density, space and time interference patterns were taken on a Mach-Zehnder interferometer. In studying gasdynamic effects involving periodic energy input, the LG-36 helium-neon laser was used as the source of emission. A Q-switched ruby laser was used for taking the space interference patterns. Interference patterns of gasdynamic perturbations show electrode shock waves, evidence of elevated energy release near the electrodes. The gas temperature as determined from the shock wave propagation velocity was found to be 1000 K in nitrogen, and still higher in CO_2. It is found that the coefficient of diffusion in nitrogen and carbon dioxide is of the order of 15 cm^2/s, which is evidence of turbulent gas flow in the channel. Gas density profiles obtained from analysis of time interference patterns show that at the limiting pulse recurrence rate when the energy input is 0.9 J, the gas density in the middle of the channel becomes constant and equal to the undisturbed value throughout the discharge region by the time the next pulse begins, i.e., the limitation of pulse recurrence rate cannot be attributed to adiabatic expansion of the heated gas plug and turbulent heat conduction with respect to the flow. Boundary layer studies showed that the gas velocity at a distance of 1 mm from the electrode is about 1.5 times lower than in the center of the discharge region. The limitation of pulse recurrence rate to about 140 Hz observed in these experiments can be attributed to density gradients in the boundary layer. Figures 10, references 12: 5 Russian, 7 Western.

[Abstract] An examination is made of the acoustic resonating properties of the gas channel in a closed-cycle CO_2 laser with pulse-periodic energy input. Experiments and calculations are done to determine how the acoustic oscillations in the gas channel influence the limitation on pulse recurrence rate in such a laser. It is found that depending on the pulse recurrence rate, there may or may not be fluctuations of gas density in the discharge gap, which is associated with excitation of a standing wave or absence of such a wave in the acoustic resonator. However, the amplitude of oscillations of gas density at the crest of the standing wave does not exceed 4%, which produces inhomogeneities of gas density of no more than 0.25% on the width of the electrode. Such inhomogeneities could not limit the pulse recurrence rate. Therefore it is concluded that limitations on the pulse recurrence rate are due to inefficient replenishing of the gas mixture in the electrode boundary layers. However, if the natural frequency of the acoustic resonator in the pulse-periodic mode falls within the working range of pulse recurrence rates, or if the ratio of the fundamental tone to the pulse recurrence rate is a small whole number, the excited standing wave may have a considerable amplitude, and the resultant inhomogeneities of gas density may lead to arcing, which should be considered in designing the gas channel of a pulse-periodic CO_2 laser. Figures 5; references: 2 Russian.

INVESTIGATION OF STABILITY AND FREQUENCY SHIFTS OF THE He-Ne/CH$_4$ LASER IN TWO-MODE OPERATION

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[Abstract] Studies are done on stability and frequency shifts in a two-mode helium-neon laser stabilized with respect to power resonance on transition $F_2^{(2)}$ of the methane molecule. This is the first time that frequence shifts of a two-mode laser have been measured as a function of fundamental emission parameters: gas pressure, pumping current, magnitude of the saturating field. An estimate is made of the repeatability of the laser frequency with adjustments in the cavity and changes of optical elements. It is shown that under certain operating conditions these lasers have a frequency stability of the order of $2 \cdot 10^{-14}$ and reproducibility of about 10^{-12}. These values could even be improved by reducing the saturation parameter of the absorbing medium by using telescopic systems. The authors thank V. A. Alekseyev for constructive criticism and interest in the work. Figures 8; references 17: 12 Russian, 5 Western.

USING LASERS BASED ON COLOR CENTERS IN ALKALI HALIDE CRYSTALS FOR
INTRACAVITY LASER SPECTROSCOPY

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[Abstract] An investigation is made of lasing action on F_2^+ centers in
lithium fluoride with hydroxyl stabilization. The crystals were grown by the
Kyropoulos procedure, and the amount of OH dopant was checked by the infrared
spectra taken on the LR-20 spectrophotometer. The color centers were induced
by gamma radiation using a Co-60 source at 330 K. Luminescence was excited
on a wavelength of 640 nm. Emission was registered by the FEU-83 infrared
photomultiplier through a DMR-4 monochromator, or by an image converter. The
lasing properties of the crystal were checked by longitudinal pumping with
a ruby laser. The emission pulse was recorded by I-920 infrared film. The
absorption spectrum of atmospheric air was studied by intracavity laser
spectroscopy without using selective elements in the cavity. Lasing was
registered at wavelengths of 905-980 nm. Sensitivity was $3 \cdot 10^{-5}$ cm^{-1},
limited by the 1 μs duration of the pumping pulse. The absorption spectra
of C_2H_2, CH_3OH and CH_4 were obtained in the same spectral region. Figures
6; references 15: 4 Russian, 11 Western.

ON THE FEASIBILITY OF USING RESONANCE-EXCITED MEDIA FOR WAVE FRONT REVERSAL

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[Abstract] An analysis is done to determine to what extent the requirements
for wave front reversal can be met by resonantly pumped active media that
are externally excited amplifiers. Basically, there are three requirements: 1)
the gain of the active medium must be much greater than unity; 2) the fre-
quency of the reversed radiation must be close to that of the initial sig-
nal; the gain of the active medium must be linearly dependent on the
intensity of the pumping radiation that is to be reversed. It is shown

that these requirements can be satisfied by molecular systems made up of simple molecules. Most suitable are molecules with large rotational constants such as hydrogen halides and ammonia. Conditions are found that ensure higher gain for the reversed wave than for other waves regardless of the degree of saturation. This requires uniform distribution of intensity with respect to transverse coordinates, which can be realized by multiple reflection of the wave in a waveguide system. Limitations imposed by contrast requirements and diffusion processes are considered. The results of this study show that passive wave front reversing mirrors can be made on the basis of resonantly pumped laser media. Figures 7; references 9: 6 Russian, 3 Western.

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[Abstract] A comparative study is done in the 114.0-200.0 nm wavelength region on the emission spectra of complete and incomplete creeping discharges, a free-spark, and a spark with insertion of a dielectric backing plate in the discharge region. A VM-1 vacuum monochromator was used and the discharge emission was coupled in through a port of MgF_2 with shortwave limit of transmission of 113.5 nm. The output signal was recorded by a sodium salicylate screen and a photomultiplier tube with integration of the current and storage by a peak detector, and subsequent registration by a chart-recording voltmeter. It was found that incomplete and complete creeping discharges are the most advantageous from an energy standpoint for preionizing pulsed gas-discharge lasers of all the sources studied in the 115-120 nm wavelength band. Such discharges have the further advantage of capabilities for optimum placement. Excitation of a line emission spectrum of the dielectric in the creeping discharge plasma and in a spark discharge plasma close to the dielectric makes it feasible to concentrate the emission energy of these sources in a desired wavelength band by appropriate selection of the dielectric materials. Figures 3; references 8: 5 Russian, 3 Western.

A TUNABLE SOLID-STATE LASER BASED ON A MICROCOMPOSITE MATRIX MATERIAL

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[Abstract] The authors consider the feasibility of using a microcomposite matrix material (MMM) synthesized at the Leningrad Institute of Precision Mechanics and Optics as an active medium for a tunable solid-state laser. The material contains quartz glass and one or more dyes. Preliminary results are given on the lasing properties of MMM containing rhodamine-6G. The specimens measured $5 \times 5 \times 8$ mm and had a rhodamine concentration varying from $3 \cdot 10^{16}$ to $3 \cdot 10^{17}$ cm^{-3}. The luminescence spectrum of the MMM is the same as that for an alcohol solution of the dye except for being shifted into the shortwave region by about 90 Å. Lasing is stimulated by both longitudinal and transverse pumping. The minimum pumping energy in the transverse arrangement is 2 MW/cm^2 for a conversion factor of 4.5%. Peak lasing power for MMM is 35 kW. Emission has low divergence and high beam homogeneity. Tuning is accomplished by introducing dispersion elements into the cavity and altering its parameters. Tests for seven hours at a pumping pulse rate of 12.5 Hz showed no noticeable degradation of the laser material. Figures 2; references 5: 3 Russian, 2 Western.

ELECTRON-BEAM-CONTROLLED INERT GAS HALIDE LASERS

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[Abstract] An investigation is made of the spectral, threshold and energy characteristics of lasers based on the excimers XeF, XeCl and KrF, and also of the characteristics of a discharge in mixtures of Ar:Xe(Kr):NF$_3$(CCl$_4$). The gas mixtures were ionized by an electron beam with electron energy of about 150 keV, average current density of 3.5-6 A/cm^2, beam cross section of ?.5 x ?? cm, and pulse duration at half-height of about 150 ns. Electron

sticking probabilities are experimentally determined for molecules of N_2 $(1.5 \cdot 10^{-9}$ $cm^3 \cdot s^{-1})$ and CCl_4 $(3 \cdot 10^{-9}$ $cm^3 \cdot s^{-1})$. New broad emission bands close to 350 and 500 nm are observed in the spontaneous emission spectra of Ar:Xe:CCl$_4$ and Xe:CCl$_4$. The optimum mixture of Ar:Xe:CCl$_4$ is close to 1500:50:1. The maximum energy (power) of laser emission of 270 mJ (about $4 \cdot 10^6$ W) is obtained close to the static breakdown voltages of the discharge gap. Maximum efficiency is estimated at 4% for this mixture at 2 atm. The optimum Ar:Xe:NF$_3$ mixture is close to 1000:10:1 with maximum efficiency of about 1.5% for the XeF laser at 1.5 atm. Maximum energy (power) of this laser is achieved with a mixture of 2000:10:1, at pressure of 4 atm, and amounts to 0.14 J (about $3.5 \cdot 10^6$ W). The lasing energy for the KrF laser in optimum mixture of Ar:Kr:NF$_3$ = 600:20:1 is only a few mJ. Figures 4, references 13: 5 Russian, 8 Western.

USING OPTICAL DELAY LINES TO CONTROL THE CHARACTERISTICS OF SOLID-STATE LASERS

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[Abstract] An investigation is made of the feasibility of controlling the output characteristics of solid-state lasers by using optical delay lines to change the effective length of the optical cavity. Studies were done on ruby, garnet and neodymium glass lasers with a change in cavity length from 1 to 1000 m. It was found that the lasing threshold is only weakly dependent on the length of the cavity. Increasing the length of the cavity while holding pumping power constant produces wide variations in the duration, energy and power of free stimulated emission of solid-state lasers. At cavity lengths of about 30-50 m, lasing takes place simultaneously on a large number of axial modes. Spontaneous partial or complete axial mode-locking can take place in such lasers. The experimental results show that the possible ranges of variation achievable by this means are: for the duration of the free emission spike--1-50 μs; for the recurrence rate of spikes--1-100 kHz; for the duration of a giant pulse--0.1-4.0 μs; for the duration of an ultrashort pulse train--0.1-4.0 μs; for the recurrence rate of ultrashort pulses, 1-150MHz; for the duration of the "traveling" pulse mode--1-50 μs; for the contrast of ultrashort pulses—10^2-10^4. Figures 2; references: 9 Russian.

A GAS LASER BASED ON A MIXTURE OF CO_2-Br_2-He WITH SOLAR EXCITATION

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[Abstract] The advantages of gases as active media for solar lasers are pointed out: low threshold pumping powers and feasibility of using large volumes. The main requirements to be met by the chosen gas or gas mixture are a wide absorption band in the visible region of the spectrum, and chemical stability. These requirements are met by halides and alkalis which dissociate with absorption of light in a broad spectral band, the resultant products being electronically excited atoms. At the same time, the process of dissociation need not lead to irreversible chemical transformations. Detailed calculations are done on the characteristics of a solar laser with active gaseous medium of CO_2-Br_2-He. Solar radiation is absorbed by bromine in a spectral band of 1500 Å and the resultant metastable atoms of $Br^* \equiv Br$ ($4^2P_{\frac{1}{2}}$) stimulate an asymmetric mode of vibrations of CO_2 molecules. The helium is needed for effective cooling of the gas by conducting heat to the walls of the vessel. Population inversion and stimulated emission are realized on the transition $001 \rightarrow 100$ of the CO_2 molecule. It is shown that the proposed medium can sustain continuous lasing with solar pumping at a realistic level of concentration of solar radiation. Figure 1; reference: 1 Russian

A TUNABLE OPTICALLY PUMPED LASER BASED ON THE CARBON TETRAFLUORIDE MOLECULE

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[Abstract] An investigation is made of the parameters of a CF_4 laser, the spectrum of emitted frequencies, the spectroscopic constants of the CF_4 molecule and the tabulation of rotational lasing lines of the CF_4 laser.

Pumping radiation in the 9μm region is absorbed by the compound oscillation $\nu_2 + \nu_4$. Lasing in the 16μm region takes place from this state level (0100) of the ν_2 band raised above the ground state by $435\ cm^{-1}$. most dangerous channel for absorption of the 16μm emission is the transition from the ground state (0000) to level (0001) of the ν_4 band. Despite the fact that the lasing frequency of 0101-0100 and the absorption frequency of 0000-0001 and 0101-0102 are displaced by the anharmonicity of the oscillations, the presence of a broad rotational substructure of the vibrational states makes this absorption one of the major factors that influence the lasing parameters. Pumping was by a pulsed CO_2 laser. Tuning of the lasing frequency of the CF_4 laser was achieved by changing the pumping frequency within the $\nu_2 + \nu_4$ absorption band. It is shown that the lasing frequency is tunable over a range of $612-645\ cm^{-1}$, and that emission can be stabilized. Lasing energies of 40 mJ were achieved in a pulse of 100 ns duration at a pumping energy of 2 J. The Coriolis constant of the upper laser level is determined, and observed emission lines of the CF_4 laser are identified. Figures 5, references 8: 5 Russian, 3 Western.

A RAMAN LASER WITH FIBER-OPTICS CAVITY

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[Abstract] The paper gives experimental results of studies of Raman emission in a YAG neodymium laser with a section of multimode quartz low-loss light guide in the resonator. The experimental setup is shown in the diagram.
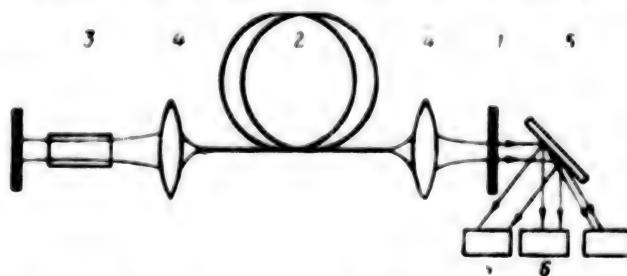
Diagram of experimental setup for observing Raman lasing: 1--cavity mirror; 2--light guide; 3--active crystal; 4--lenses; 5--diffraction grating; 6--photodiodes

The optical cavity is made up of flat mirrors that have high reflectivity in the micrometre region. Inside the cavity is a section of quartz light guide 35 m long in a coil 300 mm in diameter, a YAG crystal 40 mm long and matching lenses with focal length of 25 mm. The crystal was stimulated by a flash tube with duration of about 200 μs. The light guide has a core with diameter of 45 μm, and a shell 120 μm in diameter. The difference in indices of refraction of the core and shell is about 0.01. Losses are less than 10 dB/km. The laser emission was split by the diffraction grating into three beams corresponding to the fundamental radiation on a wavelength of 1.06 μm and the first two Stokes components, and was registered by photodiodes. Analysis of the output characteristics of the laser shows that cavity excitation of stimulated Raman scattering takes place. A study is also done on the dynamics of lasing on the fundamental and Stokes frequencies. It was found that in the process of stimulated emission in the laser two qualitatively different stages can be distinguished: the first corresponds to the initial lasing spike, and in the second stage, lasing settles down to a quasi-steady level. It is shown that a diffraction grating can be used in the cavity as a selective element for tuning the Raman laser output frequency. A system is proposed for a tuning band of 120 cm^{-1}. Figures 5, references 6: 3 Russian, 3 Western.

INVESTIGATION OF COLLISIONAL PROCESSES IN LASER SEPARATION OF ISOTOPES

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[Abstract] An analysis is done on the influence that transmission of excitation and charge transfer have on the selectivity of laser separation of isotopes for the case of a binary mixture with a relatively low concentration of atom A (the isotope to be isolated) and a strongly predominant content of atom B in the initial mixture. It is assumed that the layer of atoms A is optically thin. An examination is made of the kinetics of populations of isotopes A and B for the process of selective two-stage photo-ionization. The given analysis combined with experimental determination of the cross section of resonance transfer of excitation between isotopes of heavy elements can be used to show in any way that selectivity of isolation of a selected isotope depends on the initial density of the atoms. Figures 4; references 2.

TUNABLE SEMICONDUCTOR LASERS FOR IR SPECTROSCOPY

KURBATOV, L. N., BRITOV, A. D., KARAVAYEV, S. M. and SIVACHENKO, L. N.

[Abstract] Using injection lasers based on tin-doped lead telluride, the authors develop a laser spectrometer with resolution of at least 10^{-3} cm^{-1} in the 5-17 μm region, enabling resolution of the fine structure of the rotational-vibrational bands of a number of gases: H_2O, NH_3, CF_4, CO_2, N_2, C_2H_4 and C_6H_6. The laser diodes used in the spectroscopy experiments were made by the method of photostimulated gas epitaxy. Threshold current densities were 0.2-0.5 kA/cm^2 at liquid helium temperature. The emission wavelength was tuned by changing the temperature of the laser diode. In the case of supply by long current pulses (1 ms) at a recurrence rate of 100 hz the range of working temperatures was 4.2-50 K, enabling tuning of emission over a range of 60 cm^{-1}. Continuous tuning of an individual mode was accomplished by heating of the diode during a current pulse. The range of continuous tuning of a mode reached 2 cm^{-1}. The rate of mode tuning at the end of a pulse was 10^2-10^4 cm$^{-1} \cdot s^{-1}$, which is several orders of magnitude lower than the tuning rate with microsecond pulse supply, enabling the use of high-sensitivity photosensors and a low-frequency amplification channel without detriment to the limiting resolution. The authors thank V. G. Koloshnikov and Yu. V. Kuritsyn for assistance in decoding the NH_3 spectra. Figures 3; references 10: 3 Russian, 7 Western.

ELECTRODYNAMIC CHARACTERISTICS OF AN MHD-ACCELERATOR

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Moscow

[Abstract]   An experimental study of an MHD accelerator for space flight
simulation in wind tunnels was made for the purpose of determining the
current-voltage characteristics of the discharge, the distributions of cur-
rent, voltage and static pressure along the channel, also the edge effects
and the Hall effect. The magnet system of the device produced a field uni-
form over a 230 mm center segment and sharply tapering over 30 mm end
segments of the channel. A 3-phase transformer supplied 360 V to 22
electrode pairs through 22 separate secondaries with a 3-phase bridge
rectifier across each. The active medium was air with 1% of a eutectic KNa
alloy, preheated to 3700 K and flowing at a rate of 10^{-2} or $2 \cdot 10^{-2}$ kg/s under
a pressure of 0.22 or 0.44 MPa respectively. The velocity at the accelera-
tor input was $N_{Ma} = 2$. The test data were evaluated on the basis of numer-
ical solution of the corresponding system of MHD equations. The results
indicate that most of the applied voltage compensates the induced voltage
and the drop across the layers adjacent to the electrodes, an insignificant
part of it appearing across the conducting arc column. The readings of the
Hall-effect voltage indicate that under the given conditions the electrical
conductivity increases proportionally with the current and the electron con-
centration corresponds to a static pressure and temperature equilibrium,
effects due to buildup of ionization instability remaining negligible. The
authors thank V. A. Pleshakov and I. I. Tarasov for designing the measurement
systems and for helping with the experiment. Figures 6; references 17:
6 Russian, 11 Western.

ELECTRICAL CONDUCTIVITY OF PLASMAS GENERATED BY HIGH-PRESSURE ARC DISCHARGE
IN KRYPTON AND IN XENON

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[Abstract]   The electrical conductivity of krypton and xenon plasmas as
well as its dependence on the discharge current were measured in an experi-
ment with a high-pressure arc discharge producing an electron concentration

of approximately 10^{16} cm^{-3}. The plasmas were generated in quartz tubes with tungsten electrodes, the degree of ionization not exceeding 1%, under pressures from 0.3 to 8 MPa and with the discharge current varying from 5 to 60A. The mean temperature in the discharge region varied from 5600 to 7600 K for krypton and from 4900 to 6600 K for xenon. The radial temperature profiles and the temperatures at the discharge axis were also measured. Within this range of temperature the measured electrical conductance of the arc column, at a fixed electric field intensity, is found to be approximately twice as high as the calculated one. The authors thank A. A. Shcherbakov and V. M. Gradov for the helpful comments. Figures 3; references 12: 7 Russian, 5 Western.

ELECTRICAL CONDUCTIVITY OF HIGHLY IONIZED DENSE PLASMAS OF ALKALI METALS

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[Abstract] An experimental study of a dense nonideal lithium plasma was made to determine the temperature dependence and the pressure dependence of its electrical conductivity over the 1000-50,000 K range and the 12.5-50 MPa range respectively. The plasma was generated by electric explosion of lithium wire in an argon atmosphere under high pressure and the measurements were made by the method of isobaric heating. Here the results are compared with already available data on plasmas of gases and other metals, particularly cesium, also with the theoretical universal Spitzer's $T^{3/2}$ relation. In the case of lithium plasma the electrical conductivity is found to increase with rising pressure throughout the entire range and to decrease with rising temperature, approaching some threshold and never increasing again at high temperatures. This anomalous temperature dependence could be a consequence of the particular plasma generating and heating conditions, due to variation of the electric field intensity, or due to longitudinal temperature gradients. It would seem worthwhile to perform further similar experiments with plasmas ionizable to a still higher degree, plasmas of barium or lead for instance, but the much lower plasticity of those metals makes wire drawing very difficult. Noteworthy is that in the case of lead, with a high liquid-to-vapor transition temperature and thus long evaporation time, slow electric explosion under a high ambient pressure would be useful in a study of this transition. The authors thank E. I. Asinovskiy, A. A. Baluyev, N. N. Kalitkin and G. E. Norman for the helpful comments and suggestions. Figures 4; references: 16 Russian.

ACTION OF A POWERFUL CO$_2$ LASER PULSE ON TRIPLET MOLECULES OF DIACETYL AND
BENZOPHENONE VAPOR

BORISEVICH, N. A., BLINOV, S. I., DOROKHIN, A. V., ZALESSKAYA, G. A. and
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[Abstract] Disruption of the equilibrium distribution of triplet molecules
by an additional radiation pulse that leads to triplet-triplet transitions
or to excitation of high vibrations of the same triplet state is a promising
method of studying the relaxation rates of vibronic energy. In the research
described in this paper, a powerful laser pulse is used to disrupt the
equilibrium distribution of molecules with respect to the vibrational levels
of the lower triplet state after population inversion by a visible or ultra-
violet laser pulse as a basis for studying processes of enhancement of
fluorescence and attenuation of phosphorescence, and also for determining
the probabilities of nonradiative transitions between triplet and singlet
states. The disrupting pulse was provided by infrared radiation from a CO$_2$
laser with energy of 5 J and duration at half height of about 100 ns. The
triplet molecules studied were provided by diacetyl and benzophenone vapor
in which the nonradiative transitions between the lower excited singlet and
triplet levels have a considerable influence on emissive characteristics.
The triplet level of diacetyl was populated by a dye laser pulse with wave
length of 420 nm, which is close to the maximum of the long-wave band of
singlet absorption, and the triplet level of benzophenone was populated by
emission on the second harmonic of a ruby laser (347 nm). Vibrations of the
triplet molecules were excited by the CO$_2$ laser radiation on 10.6 μ m
after a time sufficient for establishment of vibrational equilibrium in the
triplet electron state (from 5 to 100 μ s). It was found that disruption of
equilibrium in the lower triplet state increases the intensity of emission
in the singlet transition by a factor of 40 in diacetyl, and by a factor of 2-3
in benzophenone. An analysis is made of the influence that laser pulse
power has on the intensity and time characteristics of emission in the
singlet and triplet transitions, as well as phosphorescence and activated
fluorescence. The observed unsteady changes in emission from these molecules
with CO$_2$ laser exposure can be attributed to nonequilibrium population of
high vibrational levels of the triplet state and subsequent effective triplet-
singlet exchange in the region of mixed vibronic levels. Figures 3;
references 4: 2 Russian, 2 Western.

THE ANAPOLE MOMENT OF LEPTONS AND QUARKS AS A SOURCE OF ODD-P INTERACTION
BETWEEN LEPTONS AND HADRONS

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Ukrainian SSR

[Abstract] From the standpoint of the one-photon mechanism it is shown that
odd-P effects in the scattering of polarized leptons can be induced by the
anapole moments of an electron or quarks, and that the symmetry of the scat-
tering of longitudinally polarized electrons by nonpolarized hadrons is
linearly dependent on the anapole moment (the unique odd-P characteristic
which does not conflict with CP-invariance, for particles with a spin of 1/2)
and, in this connection, both the absolute values and the polarity of the
anapole moments of the electron and quarks can be determined. A formula for
the asymmetry of the inelastic scattering of longitudinally polarized elec-
trons on any nonpolarized hadron target is derived. Models with electron or
quark anapole moments which result in identical values of the asymmetry of
e^-d scattering should result in differing intensity of odd-P effects in
atoms, namely, only the anapole moment of the electron can assure odd-P
effects in atoms comparable with the odd-P effects predicted in Weinberg's
model (S. Weinberg, PHYS. REV. LETT., 19, 1264, 1967). Figures 1;
references 4: 1 Russian, 3 Western.

OBSERVATION OF MU-NUCLEON CHLORINE ATOMS

BASHKIROV, V. A., GOVOROV, V. V., DOBRETSOV, YU. P., DOLOGOSHEIN, B. A.,
ZALIKHANOV, B. SH. (Joint Institute of Nuclear Research), ZINOV, V. G.
(Joint Institute of Nuclear Research), KIRILLOV-UGRYUMOV, V. G., NEVSKIY,
P. L., SMAKOV, A. YA., SUMAROKOV, A. V., and ROGOZHIN, A. M., Moscow
Engineering Physics Institute

[Abstract] In view of the recent discoveries of the formation of free mu-
nucleon atoms--mu-mesic atoms with a completely filled electron shell--of
fluorine and hydrogen, it was of interest to add to this roster by investi-
gating the formation of the mu-nucleon chlorine atom arising upon the capture

of polarized negative muons by atoms of argon. The experiment was performed
in the meson channel of a synchrocyclotron. The mu-nucleon chlorine atoms
were tracked through the observation of the precession of the angular dis-
tribution of $\mu \rightarrow e$ decay in transverse (relative to the muon spin) mag-
netic fields with intensities of 3 and 4.4 oersted. A special gas target
was used to record the stoppages of muons in argon; the target was filled
with a mixture of Ar and He, with the He being used as the electron donor
for the formation of the completely occupied electron shell of mu-nucleon
chlorine. The coefficient of asymmetry of $\mu \rightarrow e$ decay electrons was found
to be 0.059±0.012. Figures 1; references 6: 5 Russian, 1 Western.

BUDNEV, N. M. and POLITYKO, S. I., Irkutsk State University imeni
A. A. Zhdanov

[Abstract] The increased radiant emittance of modern accelerators with e^+e^-
opposed beams makes it possible to perform a number of exact experiments to
investigate the properties of vector mesons, including the possibility of
$\phi \rightarrow 2\pi$ decay. This paper deals with the possibility of observing that
decay according to the interference in the pion form-factor in the region

$\sqrt{s} = m_\phi$. The relative decay probability $B(\phi \rightarrow 2\pi)$ was computed
directly by using experimental data rather than concrete models, allowing
for the attendant large contribution of inelastic channels to the pion form-
factor, and introducing a correction based on the unitarity condition. Then
$B(\phi \rightarrow 2\pi) = (2.8^{+2.1}_{-1.4}) \cdot 10^{-5}$. Figures 1; references 4: 2 Russian,
2 Western.

USSR

HIGH-MULTIPLICITY EVENTS WITH INTERACTIONS BETWEEN NUCLEONS AND PHOTO-
EMULSION NUCLEI IN THE PRESENCE OF ENERGIES $\gtrsim$ 1 TeV

SHESTOPEROV, V. YA. and CHIKOVA, L. O., Institute of Nuclear Physics,
Moscow State University imeni M. V. Lomonosov

[Abstract] The tracking of visible cascades in two emulsion stacks exposed
at high altitudes revealed approximately 150 interactions between cosmic-
rays and nucleons of E $\gtrsim$ 1 TeV. The mean number of relativistic particles
in these interactions $\langle n_s \rangle$ = 25. In each of these flights one event with
$n_s \gtrsim$ 100 was recorded. Two interactions between protons and emulsion nuclei
with $n_s \gtrsim$ 100 were also discovered when tracking the cascades in the stack
exposed on the Interkosmos-6 satellite. The probability of occurrence of
events with $n/\langle n_s \rangle \gtrsim$ 4 is $\leq 10^{-3}$ according to data obtained in accelera-
tors. In this connection, experimental data on the recording of inter-
actions with $n_s \gtrsim$ 100 were compared with the anticipated frequency of such
events. The angular distribution of the nucleons incident on the stack was
assumed to be isotropic and the nucleon interaction path in the emulsion
was taken to be 35 cm. The mean distance from interaction site to the
place where the cascade is visible to the naked eye was approximately 10 cm.
The measured frequency of high-multiplicity events turned out to be roughly
ten times as high as the anticipated frequency. Figures 1; references 7:
4 Russian, 3 Western.

USSR

ON THE THEORY OF THE NUCLEAR DISPLACEMENT OF LEVELS OF THE PROTON-ANTIPROTON
ATOM

KUDRYAVTSEV, A. YE. and POPOV, V. S., Institute of Theoretical and
Experimental Physics

[Abstract] Nuclear interaction causes the Coulomb levels of atoms to undergo
displacement and acquire width; in this connection, a formula for the Coulomb-
level displacements of hadronic atoms across the scattering length on the
nuclear potential is derived. It is shown that the known displacement and
width of one of the s-levels of an atom can be used to determine the position
and width of the remaining s-levels as well as the scattering length a_s. The

experimental data on the displacement of the levels of the $p\bar{p}$ atom point
to the possibility of existence of a bound state with the binding energy
$\mathcal{E} = 0.9$ meV and width $\Gamma \lesssim$ 200 keV in the $p\bar{p}$-system and hence also to the
existence of a quasinuclear meson with mass of 1870, width $\Gamma \lesssim$ 200
keV, and spin of 0 or 1. A formula for states with the orbital moment $\ell \neq 0$
is also derived. Neither formula fits the perturbation theory, because the
attendant cutoff of the Coulomb potential substantially alters the behavior
of wave functions at short distances. Figures 3, references 7; 4 Russian,
3 Western.

USER

MANIFESTATION OF WEAK INTERACTIONS IN HEAVY ATOMS

KIRZHNITS, D. A. and LOZOVIK, Yu. E., Physics Institute imeni P. N. Lebedev
and Institute of Spectroscopy, USSR Academy of Sciences

[Abstract] The complexity of the question of the existence of a neutral
"electron-nucleon" current is noted, necessitating that the effects compli-
cating the picture for heavy atoms. This concerns the polarization of
filled shells, which alters the effective weak interaction of the nucleus
and the valence electron. Usually polarization of this kind results in
shielding the nucleus. Were this to apply to weak interaction as well, the
parity nonconservation effects of the deep atom would be suppressed and
the discrepancy between the findings of accelerator and spectro-
scopic experiments would disappear, at least. In this connection, a simple
procedure for calculating weak polarization effect (P) with respect to
any heavy atom is presented. If such the the procedure method is combined
with ... The effect that polarization of the
electrons ... has an even bolder bearing on the parity
nonconservation effect. The effect is estimated to be of an explicit function of
Z. ... nuclear spectroscopy measurement of these effects by
10-20% (the bismuth |Z = 83|, and that the positions parity noncon-
servation effect ... the applicability of the proposed method
... given also produced a 15 estimate of 15-20%,
which is in accordance with the fact that the discrepancy between the
experimental and theoretical prediction data on the line splitting also
... supports the conclusion at the root of
the ... parents at any rate attributed to the
proposed method is 15 atoms and lies in a purely
experimental ... references 7 Russian.

CLASSICAL AND QUANTUM DYNAMICS OF PARTICLES OF ARBITRARY SPIN

GERSHUN, V. D. and TKACH, V. I., Physico-Technical Institute of the Academy
of Sciences Ukrainian SSR

[Abstract] The introduction of anticommutative variables into elementary
particle physics and the research into groups of transformations with such
parameters have led to the discovery of properties of symmetry between bosons
and fermions. This approach to elementary particle physics, which has been
termed "supersymmetry," has also resulted in a new view of the earlier
attempts to formulate the Hamiltonian mechanics of spin for point particles,
based on the consideration of the Grassman variables, associated with the
spin degrees of freedom. In this connection, in this paper the classical
and quantum mechanics of a point particle with the spin $n/2$ is constructed
on the basis of the field approach to supergravitation (D. E. Freedman and
P. van Nieuwenhuizen, PHYS. REV., D14, 912,1976) with the internal local
symmetry group $O(n)$. The pertinent quantum theory is constructed by super-
posing canonical commutation relations. A Lagrangian invariant with respect
to the internal local group $O(n)$ and describing the mechanics of a material
point with the spin $n/2$ is constructed on the basis of the Grassman variables.
The motion of a particle of arbitrary spin is analogously considered.
References 8: 2 Russian, 6 Western.

ALPHA-RAY REACTION FORCES AND LASER-DRIVEN FUSION

RUMYANTSEV, A. A. and KULAKOV, A. V., Leningrad Polytechnical Institute
imeni M. I. Kalinin

[Abstract] Attention is focused on the need to take into account the
forces of reaction exerted on the plasma from the alpha particles produced
in laser-driven fusion. In this plasma the time for nuclear burnup has
been shown to be relatively long as compared with the typical hydrodynamic
period, for example, and ways are being sought to find possible mechanisms
for containment of the plasma or at least for the retardation of its
expansion. The practical application of laser-driven fusion is shown to
be feasible by utilizing the forces of reaction of alpha radiation under the

conditions described. A magnetic plasma cloud is discussed, consisting of
a mixture of deuterium and tritium in equal concentrations. The plasma
burns for a period of time and the loss energy is converted into the
thermal energy of the particles. It is assumed that the pulse transmitted
to the plasma by alpha particles or the point pulse when they escape from
the plasma is sufficient to increase the pressure gradient in the plasma by
T/a, where T is the temperature and a is the radius of the cloud, per
particle. The force of the reaction from escaping alpha particles is trans-
mitted to all particles in the plasma by means of the electric polarizing
field. The period for the diffusion of alpha particles should not be longer
than the time for their thermalization. Subsequent to the plasma cloud
thermonuclear fusion begins, with the release of neutrons and alpha par-
ticles, these repel from the plasma, but if a concentration not
exceeding the threshold is reached, or the thermalization of alpha par-
ticles. All the parameters such as the plasma and initial concentra-
tion, radius of the cloud and radiation are usually given specific values.
Practical application is possible only under these condi-
tions if the irradiation period is longer in the order of 10^{-6} s.
An example is given of reproduction of the force of reaction on the part of
escaping alpha particles. Figures 1; references - Russian.

USSR

UDC 621.372.413

INSTABILITY OF THE WALLS OF A RESONATOR UNDER THE EFFECT OF PONDEROMOTIVE
FORCES IN THE PRESENCE OF A FEEDBACK AND STABILIZATION OF AMPLITUDE OF THE
RESONATOR EXCITING FIELD

Leningrad RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 24, No 1, Jan 79
pp 90-96 manuscript received 15 Jun 78

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[Abstract] An exciting current feedback loop is employed for the purpose of
stabilizing the operation of low-frequency systems with high-frequency power
generators used. If the mechanical oscillation of electron-positron
storage rings. If the cavity frequency is somewhat lower than the
frequency of the exciting current, the walls of the cavity begin to vibrate
with the voltage at the cavity frequency than its threshold. The frequency
of the cavity is such that the voltage in the cavity is modulated
with frequency oscillation of the
walls. If the frequency of the cavity is
slightly changed, so that it is impossible to
measure the exciting current frequency or
until, because the cavity walls move abruptly

under the effect of ponderomotive forces, or static instability takes place.
The threshold voltages at which these forms of instability are evidenced
can be reduced considerably by including a feedback loop which stabilizes
the amplitude of the exciting current. An investigation is made here of the
influence of feedback on the electromechanical instability threshold. An
equation is derived for the electromechanical vibrations, based on an equiva-
lent circuit for the resonator cavity and generator in a high-frequency
system with feedback. Conditions are derived for the stability of the
electromechanical system, taking feedback into account. Using the cavity of
a VEPP-2 accumulation as an example, a comparison is made between calculated
and measured threshold voltages for the origin of vibrational instability for
various parameters of the feedback loop. Good agreement is found. An
automatic current level control circuit is employed to regulate the amplitude
of the current exciting the cavity. The parameters of this circuit are com-
pared with the threshold voltage. Figures 3; references: 7 Russian.

A TANGENTIAL CHANNEL FOR GAMMA NUCLEAR RESONANCE SPECTROMETRY IN THE AL
NEUTRON CAPTURE

VELOGUROV, V. N., BONDARS, KH. YA., LAPENAS, A. A., REZNIKOV, R. M. and
SEN'KOV, P. YE., Institute of Physics, Academy of Sciences LatvSSR

[Abstract] The paper describes a tangential channel installed at the loca-
tion of the radial horizontal experimental channel of the IRT-2000 nuclear
reactor at the Institute of Physics of the Latvian Academy of Sciences.
A single-section gate is used with the axis of the channel at an angle of
$7°$ to the axis of the gate. In the open state, the axis of the channel
passes through the beryllium reflector close to the reactor core (see the
diagram). To avoid crossing other channels, the tangential channel drops
below them. Placement of the facility at the location of the radial hori-
zontal experimental channel avoids the problems of cutting another beam hole
through the biological shielding. The characteristics of the neutron
spectrum and gamma background at the channel outlet are given, and a com-
parison is made with like characteristics of the radial channel. Gamma
spectra are presented for reactions of thermal neutron capture by isotopes
of Gd^{155}, Gd^{157}, Er^{167} and Hf^{177} on which the Mössbauer effect can be
observed. The authors thank V. V. Gavar and V. Ya. Mozgir for useful dis-
cussions and assistance with the work. Figures 5; references 5: 2 Russian,
3 Western.
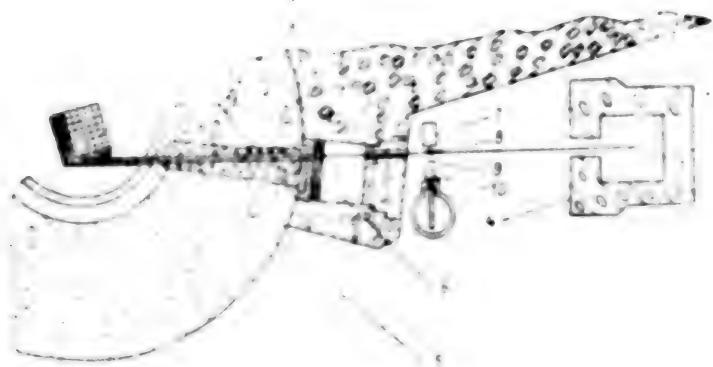
Diagram of the horizontal tangential channel for gamma nuclear resonance spectrometry: 1--reactor core; 2--beryllium reflector; 3--gate; 4--reactor emission trap; 5--biological shield; 6--filter chamber; 7--electromagnetic vibrator; 8--target specimen; 9--resonance absorber; 10--detection unit

USSR

OPTICAL SYNCHRONOUS DETECTION

TYCHINSKIY, V. P., Moscow Institute of Radio Engineering, Electronics and Automation

[Abstract] It is shown that the spectrum of the photocurrent of a twin-beam interferometer with a scattering object provides information on its total corpus of first-order spectra. A formula is proposed for separating the spectra of amplitude and phase oscillations of the medium according to four independent measurements of the spectrum of power fluctuations $W(\psi) = \pi^{-1} \int_0^{\infty} g_i(\tau) \cos \Omega \tau \, d\tau$ for $\psi = \pm \pi/2, 0, \pi$, where ψ is the steady-state phase difference, and $g_i(\ )$ is the autocorrelation function of the photocurrent for gaussian random processes.

USSR

LATENT STRUCTURE OF THE QUASISTATIC LIMB OF THE ATOMIC LINE OF RUBIDIUM

VARTANYAN, T. A., MAKSIMOV, YU. N., PRIZHBEL'SKIY, S. G. and KHROMOV, V. V., State Optical Institute

[Abstract] In connection with the rising interest in nonlinear optical effects in systems of colliding atoms, due to the nontrivial nature of these effects as well as due to their potential applications in the development of excimer and gas-dynamic recombination lasers, research into the potential of interatomic interactions, the kinetics of gas-phase chemical reactions, etc., this communication demonstrates the effectiveness of the method of laser saturation spectroscopy in research into atomic collisions. The system Rb + Xe was selected for investigation. Excitation of the shortwave limb of the D_2-line of Rb (transition $X^2\Sigma_{1/2}-B^2\Sigma_{1/2}$) was accomplished by means of a laser ($\lambda = 750$-780 nm, $\tau = 20$ ns, $\Delta\lambda = 5$-10 cm^{-1}). The integral luminescence intensity of the Rb line ($\lambda = 780$ nm) was measured with the aid of an FEU-84 photomultiplier at right angles to the direction of the exciting beam via an MDR-2 monochromatic illuminator. The vapor pressures of Rb and Xe were

10^{-3} and 30 mm Hg respectively. This revealed the latent structure of the nonlinear spectrum of the excitation of atomic fluroescence: in the inhomogeneous ensemble of colliding atoms there exists a small group for which the probability of excitation by radiation with $\lambda = \lambda_s$ is much greater than

for the other atoms. The nature of this latent structure is explained from the standpoint of the quasistatic theory of the limb of the line and its discovery is construed as a direct proof of the inhomogeneity of line broadening. This broadening, unlike Doppler broadening, is associated with the inhomogeneity of the ensemble of relative energies and impact parameters of the colliding atoms. It is demonstrated that the spectral characteristics of the latent structure are determined by the fine parameters of interatomic interaction and can be used to determine the latter. Figures 2; references 6: 5 Russian, 1 Western.

FOCUSING AND DEFOCUSING OF LIGHT DURING THE BURSTING OF AEROSOLS IN LASER BEAMS

KOLOSOV, V. V. and KUZIKOVSKIY, A. V., USSR Academy of Sciences Siberian Division Institute of Atmospheric Optics, Tomsk

[Abstract] With laser pulsed emission of sufficiently high power it is possible to produce a channel free from aerosol by means of gas dynamical bursting of drops, when using a laser to penetrate clouds and fog, for example. The dynamics of illumination can be influenced considerably by a number of accompanying effects. A study is made here of the influence that the regular part of the oscillators of gas dynamical processes has on conditions for the propagation of a propagating light beam in the resultant channel. It is assumed that the aerosol is polydispersed and that the bursting of the drops in the channel occurs simultaneously. Each drop is the source of a shock wave, which, when it overlaps perturbations from neighboring drops, changes into a sonic wave, and as of this moment the pressure and density in the channel and the refractive index, can be represented as the sum of its regular and fluctuating parts. It can be concluded from the equations derived in the theoretical discussion presented that under gas dynamic conditions for the bursting of drops of fog whose water content is 0.1 g/m³ the refractive index gradients which originate cause beams to deflect at angles which are an order of magnitude greater than the diffraction angles. With a greater water content, transverse gradients originate ... ... ation of the influence of gas dynamical

processes on propagation of the light beam is approximately equal to the
time of the mean free path of sound in relation to the diameter of the beam.
This duration is independent of the water content of the aerosol and the
power density of the beam. Curves are shown for the distribution of
intensity of the probing beam at a given moment and the distribution of
pressure in the channel at the same moment. A "kink" in the pressure dis-
tribution results in a sudden change in the refractive index gradient,
which causes a surge in intensity. Focusing and defocusing alternate.
Figures 2; references 3: 2 Russian, 1 Western.

PRODUCTION OF HOLOGRAMS ON SHIFT INTERFEROMETERS WITH A BROAD LIGHT SOURCE

ZEYLIKOVICH, I. S., KOMISSARUK, V. A., KOMISSARUK, I. I., and MEN...,
Institute of Physics and Technology imeni A. F. Ioffe, USSR Academy of
Sciences, Leningrad

[Abstract] A polarization interferometer with a broad source of light pro-
duces contrast bands over the entire field of interference. Recorded on
film, these interference patterns allow the use of several methods of holo-
graphic interferometry and shadow methods of studying the reconstructed wave
front. In ballistic experiments, the light source is a Q-switched pulse
laser. The light source used in these experiments was a type OGM-20 laser,
with the spatial coherence of the radiation reduced by increasing the pump-
ing energy level to above the threshold level and stabilizing the cooling
water to 20-25°C, producing interference patterns of very high quality,
having the properties of holograms. This article describes installations
for reconstructing wave fronts with these holograms and presents several
pictures made with them. Color shadow pictures produced have very high
color contrast and provide a very clear picture of the photo being studied.
Figures 4; references 5: 4 Russian, 1 Western.

OPTICAL PROPERTIES OF CO_2 PLASMA AT ATMOSPHERIC PRESSURE IN THE SPECTRAL RANGE OF 400 TO 1200 nm AT 10^4 TO 2×10^4 K

AZHARONOK, V. V., GUBKEVICH, V. A., CHUBRIK, N. I. and SHIMANOVICH, V. D.

[Abstract] Spectral absorption abilities of highly heated carbon dioxide gas must be studied to understand the physical processes occurring in plasma and for some other technical problems connected with hypersonic entry of space vehicles into the atmosphere of Venus. Experimental measurements were made using a KDSh-500 electric-arc discharge device (discharge current = 300 amperes) with an average current density across the arc of about 1500 amperes per square centimeter. A five-fold enlargement of the discharge channel image made it possible to obtain three-dimensional resolution of at least 20 points in the radius of the plasma pinch with a 0.5 mm monochromator input slit aperture width. The authors determine the optical coefficients of absorption of a CO_2 plasma at atmospheric pressure in the temperature ran range of $1.6 \cdot 10^4$-$2 \cdot 10^4$ K. Spectral resolution is of the order of 2.4 nm. By using the results along with the data in the literature, they calculate the integral characteristics of an infinite plane-parallel layer of highly heated carbon dioxide at $T = 10^4$-$2 \cdot 10^4$ K. The paper describes updated processing algorithms and a device for display of experimental data based on the KSP-4 potentiometer of the AIVS automated computer measurement system. The results of the work are compared with the data in the literature. The plasma generator is a stabilized electric arc held steady by swirling gas. Figures 4; references 27: 23 Russian, 4 Western.

SPECTROSCOPIC STUDY OF LASER-INDUCED BREAKDOWN IN HELIUM NEAR A TARGET

GOLUBEV, V.S. and SNOPKO, V. N.

[Abstract] Gas breakdown induced by carbon dioxide laser emission near a target is of particular interest. Alignment of the target at the focal point of emission reduces the breakdown threshold by two orders. Due to the great wavelength of carbon dioxide laser emission it can be absorbed intensively by free electrons in the plasma owing to the reverse braking effect. Helium is an interesting gas for study of laser-induced breakdown:

published studies have revealed some differences in results due to shortcomings in theoretical models, plasma heterogeneity, or imperfect methods of measurement. Helium breakdown by a carbon dioxide laser on a copper target was studied using a transverse discharge laser operating under multimode conditions. Pulse energy comprised 1.5 joules lasting 5 microseconds (base length). Emission was focused on the copper target in a chamber containing helium at pressures ranging from 0.001 to 6 atmospheres. The magnitude of the peaks and the halfwidth of the line are mainly determined by the zones of peak emission intensity. Zones having low electron concentration yield line contours with less spectral width. The spectral interval between peaks corresponds to a lower electron concentration than the line halfwidth. Figures 5; references 16: 6 Russian, 10 Western.

ODINTSOV, A. I., SOKOLOVSKIY, R. I. and YAKUNIN, V. P., Physics Department, Moscow State University imeni M. V. Lomonosov

[Abstract] Recent studies have shown specific polarization of superluminescence of gases and metal vapors due to Zeeman splitting of levels in the magnetic field of a strong-current longitudinal discharge. The difference in gain for the π and σ components of the spectral line leads to preferred azimuthal orientation of the electric vector $\vec{\mathcal{E}}$ in the cross section of the superluminescence beam. In this paper, a theoretical and experimental study is done on this phenomenon. Formation of the polarized superluminescence is described within the framework of the simplest models that permit explanation of the major features of the effect. The starting point is the equation for slow field amplitudes in the parabolic approximation:

$$\left(\frac{\partial}{\partial z}+\frac{1}{2ik}\Delta_{\perp}\right)\vec{\mathcal{E}}_i = \sum_{-i,j} \alpha_{ij}\vec{\mathcal{E}}_j$$

where $\Delta_{\perp}$ is the laplacian with respect to transverse coordinates, the z axis is directed along the axis of the radiating tube, α_{ij} is the tensor of the gain of the anisotropic medium, $k = 2\pi/\lambda$. It is assumed that the gain is high enough so that superluminescence takes place by amplification of the noises present at the inlet end of the tube. It is assumed that gain as a

function of distance from the center of the discharge is proportional to current density. It is shown that the degree of polarization increases from zero at the center of the beam to some maximum value at the periphery, and then falls off. The degree of polarization increases both with increasing gain and with increasing magnitude of Zeeman splitting. Saturation reduces the degree of polarization of superluminescence. Experimental studies in neon showed that diffraction effects have maximum influence at low gas pressures, where the beam is channeled along the axis of the discharge tube and its transverse dimensions decrease. The authors thank V. A. Gorshkov for doing some of the calculations. Figures 4; references 13: 11 Russian, 1 Western.

POLARIZATION OF ELECTRONS AND NUCLEI IN RESONANT MANY-PHOTON IONIZATION OF ATOMS

DELONE, N. B. and FEDOROV, M. V.

[Abstract] The authors examine the physical principles of polarization of the electrons and nuclei of ions that are formed in resonant ionization of unpolarized atoms by circularly polarized light. The polarizing effects are based on the process of selective excitation of an atom to a certain state of the fine or hyperfine structure, and subsequent ionization of the excited atom by circularly polarized light. Absorption of a quantum (or several quanta) of circularly polarized light leads to a change in the moment of the atom by a certain amount, and hence to nonequilibrium population of excited states, i.e. to a certain degree of polarization. The problem of optimizing experimental conditions, including light intensity, is examined. Figures ; references , 10 Western.

Optoelectronics

KINETICS OF CHARGING OF THE SURFACE OF ELECTRO-OPTICAL CERAMICS WITH AN ELECTRON BEAM

BUTUSOV, M. M., IVANOV, A. V., KOSAREV, A. I., MYL'NIKOVA, I. YE. and TUKHVATULIN, R. SH., Leningrad Polytechnical Institute imeni M. I. Kalinin

[Abstract] An investigation is made of the kinetics of charging and discharging of the surface of LZT-La electro-optical ceramics on account of secondary electron emission when a sample is exposed to an electron beam. The purpose of the study is to investigate the feasibility of using electro-optical ceramics as a light modulating medium in a stereo light modulator. The experimental setup consisted of a vacuum unit containing an electron gun and a target unit, the latter consisting of the sample studied and a conducting backing attached to a metal plate. A close-range receiver in the form of a grating was placed 0.5 mm from the surface of the sample. The sample had the composition $(Pb_{0.91}La_{0.09})(Zr_{0.65}Ti_{0.35})O_3$ and was 15 mm in diameter and 0.5 mm thick. Charging and discharging processes were studied by measuring the amplitude of current pulses in the target circuit. The electron gun had a pulse length of 10 μs, a pulse current of 10^{-6} A, a pulse repetition period of 1.6 to 10 kHz and an acceleration voltage of 0.6 to 10 kV. The close-range receiver's grating was supplied with a potential of $\pm$ 120 V, which made it possible to select or cut off secondary electrons. The coefficient of secondary electron emission was measured by both the single pulse and recurrent pulse methods. The energy of primary electrons varied from 0.6 to 10 keV. It was found that a positive charge of $4 \cdot 10^{-9}$ coulombs is applied to the surface of these ceramics in about 10^{-1} s with a beam current of about 10^{-6} A. It takes about 10^{-3} s to impart a negative charge to the surface to a potential of the same magnitude. Curves are derived for the dependence of the current in the target circuit on time when charging and discharging the surface of the sample with the electron gun, the dependence of the charge on the surface on time, and the dependence of the current in the target circuit on time with the energy of primary electrons greater than 6.5 keV, a grating potential of + 120 V, and a beam current of about $5 \cdot 10^{-7}$ A. The experimental data compare favorably with the calculations. It is concluded that materials having a high coefficient of secondary electron emission and not too high dielectric constant should be selected as a light modulating medium for the purpose of improving the speed of recording information. The mode enabling complete screening of secondary electrons should be employed in space-time recording of information with an electron beam with its subsequent conversion into optical information; reduced image contrast results from using the mode in which secondary electrons are cut off, for they are then redistributed over the surface of the target. The latter mode can be used only for the purpose of the intentional erasing of information. Figures 3; references: 6 Russian.

RECORDING AN OPTICAL IMAGE ON A MULTILAYER STRUCTURE WITH As_2Se_3 PHOTO-SENSING ELEMENT

MAKARYCHEV, V. A., MONTRIMAS, E. A. and TAURAYTIS, A. S., Vil'nyus State University imeni V. Kapsukas

[Abstract] An experimental study is done on the electrophotographic color process to investigate the mechanism of optical image recording and to determine the sensitometric characteristics of this process on a metal-semiconductor-dielectric structure using As_2Se_3 as the semiconductor layer. To avoid rapid dark relaxation of the latent electrostatic image, the charge is accumulated on the dielectric as the image is exposed during charge exchange of the outer dielectric surface. Relations are established for the contrast of the latent image with respect to potential and density of the surface charge as a function of the conditions of charging and image recording, the intensity of illumination and exposure time. It is shown that the values of photographic latitude and dynamic range with respect to the output signal of the investigated structure depend on recording time and are inter-related with image contrast. The minimum level of illumination is determined by the rate of thermal generation of charge carriers in the photo-sensitive layer, while the coefficient of photovoltaic conversion is a function of illumination. The particulars of image recording and the sensito-metric characteristics are determined by the monopolar electrical conductivity of the As_2Se_3 in the multilayer structure, and depend on the parameters of the external circuit. It is concluded that As_2Se_3 layers can give high sensitometric parameters when used in multilayer structures with charge exchange of the outer surface of the dielectric provided that the time of charge exchange of the structure is about 0.1 s. Figures 6; references 9: 6 Russian, 3 Western.

IONIC TEMPERATURE OF THE PLASMA NEAR THE ANODE OF A DUOPLASMATRON

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[Abstract] An estimate is made of the mean energies of positive hydrogen
ions in the plasma near the anode of a duoplasmatron on the basis of measure-
ments of the gas temperature. The experimental setup employed is described
in an earlier study. Key measurements are made with the pressure of the
hydrogen in the region near the anode equal to 0.06 ± 0.01 mm Hg, the longi-
tudinal component of the magnetic field strength equal to 3.2 kilogauss, and
discharge currents of 0.25 to 2.65 A at the floating potential of the inter-
mediate electrode. The gas temperature is determined from the relative
intensities of the electron vibrational and band spectrum of the hydrogen
molecule. Measurement results are plotted on a curve illustrating the
dependence of the gas temperature of the plasma near the anode on the dis-
charge current. Taking the high thermal conductivity of hydrogen into
account, the gas temperature at zero discharge current is assumed to equal
282 K, i.e., the temperature of the copper walls of the discharge chamber,
cooled with circulating water. The gas temperature is on the order of 1000 K
for currents of 1 to 3 A typical of hydrogen duoplasmatrons. This temperature
corresponds to a mean propulsive force of about 0.1 eV. The electric field
strength in the plasma near the anode is about 1 V/cm. The rate of drift for
H_2^+ equals $(2$ to $3) \cdot 10^5$ cm/s, and for protons $5 \cdot 10^5$ cm/s. It is concluded
that the mean energies of H^+ and H_2^+ ions and molecules in the plasma near
the anode of a hydrogen duoplasmatron essentially do not differ and equal
approximately 0.05 to 0.1 eV at currents of 0.25 to 2.65 A. Figures 1;
references 9: 7 Russian, 2 Western.

PROBE DIAGNOSIS OF FLUCTUATIONS IN PLASMA POTENTIAL IN DIODES WITH EXPLOSIVE
EMISSION

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[Abstract] A description is given, and the results are discussed, of an

experiment in which a floating probe in the form of a copper wire 0.5 mm in diameter with a collecting surface 2 mm long is used to detect possible fluctuations in the plasma potential of a cathode flare in a diode which emits current bursts, in the unsteady current takeoff mode, which is characterized by the transition of the cathode plasma's emission limit into the saturation mode, whereby the mean rate of growth in current is reduced. Voltage pulses with an amplitude of $23 \cdot 10^3$ V and a length of $2 \cdot 10^{-6}$ s are supplied to a hemispherical anode with a 25-mm radius, from a generator with a wave impedance of 75 Ω. The cathode is a copper wire 15 mm long and about 50μ m in diameter, which is placed in the center of the hemispherical anode. The probe is inserted in the interelectrode gap and leads via a current-limiting resitor to an S7-10A oscillograph with a sensitivity of $65 \cdot 10^3$ V/mm and an input impedance of 50 Ω. The current is recorded with an I2-7 oscillograph, connected between the cathode and a resistor leading to ground. The current-limiting resistor in the probe circuit has a resistance of $136 \cdot 10^3 \Omega$, ensuring 10-percent precision in tracing the plasma potential via the probe's potential. A number of preliminary experiments are conducted for the purpose of revealing the nature of the behavior of the probe in a diode with explosive cathode. The results testify to good response of the probe to variation in the plasma potential and to good transmission by the probe of the fluctuation range. The results of the main experiment demonstrate that bursts of current of anomalous amplitude are caused by the origin at the cathode plasma front of discontinuities which can account for 30 to 80 percent of the voltage in the diode available at the instant of a current burst. In other words, these bursts are caused by the charging of plasmoids extending to the front of the cathode flare, and the difference in potentials between the plasmoid and the main plasma of the cathode flare can reach 60 percent of the voltage present in the diode. Results obtained in supplying a double voltage pulse to the diode demonstrate that at the instant the second pulse is supplied to the diode almost all the plasma of the cathode flare formed in the first pulse is charged, and remaining uncharged is only a plasma region about 1 mm long directly adjacent to the cathode. The voltage drop in this instance amounts to 80 to 90 percent of the voltage in the diode. The results obtained here confirm a mechanism suggested earlier for the formation of current bursts in these diodes. Figures 7; references 16: 14 Russian, 2 Western.

B. I.

[Abstract] Elements can be separated by mass in plasma centrifuges, which utilize electric discharges in crossed electric and magnetic fields. The unit consists of a metal cylindrical chamber placed in a longitudinal magnetic field with insulators closing the chamber's ends. When a high-power electron beam is passed along the unit's axis, a plasma beam discharge occurs, which ionizes the gas in the chamber. A difference in potential is created between the anode of the electron gun and the walls of the chamber, for the purpose of creating a radial electric field. The crossed electric and magnetic fields cause the plasma to rotate, whereby ions with different mass are separated, the effectiveness of the separation depending on the relative differences in mass. The separation effect has been explained by two mechanisms, the centrifugal and polarization. In the first, forces of friction caused by the collision of ions cause particles to drift radially, with light ions moving to the center and heavy to the periphery. The second mechanism is associated with processes taking place near the end insulators in the layer near the wall. A change in the density of the plasma in this layer means a change in the electric field for particles moving along the system's axis; the variable electric field causes so-called polarization drift, which is associated with the change in the rate of electrical drift. The rate of polarization drift depends on the mass of the ion, and ions with different mass are separated in the process of radial movement in the layer near the wall. The centrifugal mechanism thus involves the rotation of the plasma and the existence of collisions of ions in the unit's space. The rate of ion collisions depends directly on the plasma's density; centrifugal separation cannot occur with a low-density plasma in which ion-ion collisions do not occur. The polarization mechanism takes place over a wide range of density, and is not associated with ion-ion collisions. At high plasma densities it competes with the centrifugal, but with low enough densities it is the sole separation mechanism. Preference should thus be given to the polarization mechanism in selecting the physical and geometrical parameters of a plasma centrifuge. Estimates are made of separation parameters with which one mechanism or the other becomes dominant. For the separation of elements in a plasma centrifuge the length of the unit must satisfy the following inequality: $L \text{ (cm)} \lesssim 10^7 H^2 T_i^{3/2} \sqrt{T_e R} / E n_e A$, where E and H are the strength of the electric and magnetic fields, respectively, T_i is the temperature of the ions in eV, R is the radius of the chamber, n_e is the density of the plasma, and A is the atomic number. For neon isotopes Ne^{20} and Ne^{22}, $L \leq 600$ cm for the specific parameters given here. To maintain high separation factors when increasing the density of the plasma in the unit it is necessary to increase the magnetic field strength and temperature of the ions or to increase the radius of the system. Figures 1; references 7: 4 Russian, 3 Western.

THEORETICAL INVESTIGATION OF HIGH-SPEED PLASMA FLOWS EMANATING FROM THE
CATHODE SPOT OF A VACUUM ARC

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[Abstract] It is demonstrated that the solution to the problem of the
divergence of a jet of vapor from a cathode spot is of fundamental importance
for solving a number of problems in the theory of a cathode spot, and for
making it possible to compare measured and calculated values of the parame-
ters of a cathode spot. An approximate solution is given to this problem for
the case of a cathode jet emanating from a cluster spot. The problem of the
divergence of a jet of vapor from the region near the cathode is given a
very simple formulation. The spot is assumed to be round and the jet to be
a round truncated cone, whereby all the jet's parameters are invariable in
its cross sectional plane. The problem thus boils down to calculating a
one-dimensional flow of gas in a duct of assigned shape. The cathode jet
consists of two sections. Near the cathode is a region in which flow is
described by gas-dynamic equations. Abutting this region is an extensive
region in which particles move without collisions and in which the structure
of the jet, e.g., its degree of ionization, the number of multiply charged
ions, and the like, does not change; the velocity of particles, however,
can change because of interaction with the electric field which arises in
this region because of the distribution of charges. The distance from the
cathode at which the concentration of collisions is a certain value and
which defines the length of the collision region is shown to depend on the
nature of the divergence of the vapor, i.e., the degree of expansion of the
jet and the amount of acceleration. The length of the region in which col-
lisions are substantial is estimated by the distance at which the mean free
path equals a characteristic dimension of the system, in this case, the dis-
tance from the cathode to the anode. A system of equations is derived which
describes the flow of the gas in the jet. The theoretical notions developed
were applied to jets emanating from cathode spots in copper, nickel and
iron. The relationship is shown between the velocity of the jet remote from
the cathode and the flare angle of the jet, and also the arc's current.
[...] the distribution of parameters along the jet and the influ-
ence of the cathode drop on the existence of solutions for
a given cathode, inasmuch as presently there are no methods for making a
direct determination of the cathode drop with a margin of error smaller than
[...] approach to the problem of the divergence of a cathode
jet in a vacuum makes it possible to describe an entire group of well-known
experimental facts, and calculated values of jet parameters, both remote
from the cathode and close to it, agree well with measured parameters.
Figures 4; references 12: 6 Russian, 6 Western.

PECULARITIES OF SPONTANEOUS INTERRUPTION OF CURRENT IN A HIGH-CURRENT,
LOW-PRESSURE DISCHARGE IN A MIXTURE OF CESIUM AND BARIUM

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ENDER, A. YA., and YUR'YEV, V. G., Institute of Physics and Technology
imeni A. F.Ioffe, USSR Academy of Sciences, Leningrad

[Abstract] When the discharge current density reaches a certain critical
value in a high-current, low-pressure discharge in cesium and barium, the
current is spontaneously interrupted under certain conditions. This article
presents a detailed study of this type of interruption for a Knudsen dis-
charge in a cesium-barium switching element. It was found that the current
density at which spontaneous damping of the discharge occurs is close to the
maximum electron flux density which can be compensated by ions upon complete
ionization of the cesium atoms in the interelectrode gap. The great length
of the critical current pulse observed was explained by assuming the exist-
ence of atoms desorbed from the surfaces of the anode and grid. This hypo-
thesis also explains the relaxation time observed after spontaneous inter-
ruption of current, since it is required to restore the concentration of
cesium atoms. Spontaneous interruption is always proceeded by oscillations
in the plasma. The study of spontaneous current interruption in a cesium-
barium switching element is closely related to the study of the nonlinear
oscillations of the plasma of the discharge. Figures 3; references 20:
11 Russian, 9 Western.

CALCULATION OF THE MEAN FREE PATH PHOTONS IN MULTICOMPONENT MULTIPLY IONIZED
PLASMA

ROMANOV, G. S., STANCHITS, L. K. and STEPANOV, K. L.

[Abstract] Methods of calculating optical characteristics of multicomponent
plasma for arbitrary values of temperature and density in the weakly nonideal
approximation are presented. Results of numerical calculations carried out
for a plasma with composition of air, water and quartz in the temperature
range $1-10^4$ eV and density of about 10^{-7} to 10^1 g/cm^3 are cited. We must

first know the ionization composition of a given mixture of elements to determine the optical properties of a plasma, using a system of Saha equations for the solution. A comparison of the results of various approximations for air in the interval $1\text{-}10^3$ eV and density of about 10^{-3} to 10^{-7} g/cm^3 reveals significant uncertainty in the magnitudes of l_R and l_{pl}; in some regions this may reach one order or more. The same situation would seem to take place for water and silicon dioxide. The calculations demonstrate qualitative relationships of average paths of emission as a function of thermodynamic variables (allowing for the reservations made) and may be used to evaluate the order of magnitudes of l_R and l_{pl} in a wide range of parameters T and ρ. Figures 3; tables 1; references 7: 6 Russian, 1 Western.

DIAGNOSIS OF A RAREFIED PLASMA BY THE PROBING METHOD AND THE PHOTOMETRIC METHOD

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[Abstract] The electron concentration in a rarefied plasma generated at the surface of solids in a high-velocity stream of low-density nitrogen $(1.6 \cdot 10^{-5}$ mm Hg) was measured with electrical probes and by the photometric method. The electron temperature in the free stream remained almost constant. The close correspondence between the blackening intensity on the photographic film and the probe readings suggests that, with proper calibration, photometry can be used for diagnosis of the plasma structure under such conditions. The article was deposited at the All-Union Institute of Scientific and Technical Information 6 Feb 79, No 488-79 Dep.

RADIATION FROM A HIGH-PRESSURE AIR PLASMA

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[Abstract] An experimental study was made to determine the optical proper-
ties of a shock-compressed air plasma. The continuous radiation from such a
plasma under a pressure of approximately 100 MPa and at a temperature of
approximately 13,000 K was measured by recording the dependence of the ther-
mal emission intensity on the thickness of the plasma layer between the
shock wave front and the contact surface. From these data were calculated
the absorption coefficient and the gas thermodynamic parameters of the plasma
at three wavelengths (668, 580, 490 nm). A comparison with results obtained
by other authors indicates that theoretical calculations on the basis of the
fundamental differential equation yield lower values for the absorption
coefficient of air plasma than do measurements. This difference is attrib-
utable to photodissociation of the unstable negative nitrogen ion. Figures
4; references 32: 29 Russian, 3 Western.

NUMERICAL ANALYSIS OF TRANSIENTS IN THE POSITIVE COLUMN OF A DIFFUSIVE HIGH-VOLTAGE DISCHARGE: PLASMA BUILDUP AND DECAY WITHIN THE POSITIVE COLUMN IN AIR

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[Abstract] Transients in the positive column of a diffusive high-voltage
discharge, namely plasma buildup and decay, are analyzed on the basis of a
numerical solution of a system of partial differential equations and a
system of differential equations describing the "nonhomogeneous discharge"
model for air. First a constant current is applied and then a constant
voltage is applied, in the latter case with either a small or a large fixed
ballast resistance. A region of high electric field intensity is found to
be moving toward the anode. Plasma decay is considered without an electric
field in the positive column or with given voltage across the latter. The
analysis takes account of the detachment of electrons from gas molecules as

well as electron-ion recombination and the role of these processes during various stages of the transient period. Figures 4; references 11: 10 Russian, 1 Western.

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[Abstract] The buckling of a circular cylindrical shell whose edges rest on
a hinged joint is investigated by the geometric method (A. V. Pogorelov,
"Geometricheskiye metody v nelineynoy teorii uprugikh obolochek" [Geometric
Methods in the Nonlinear Theory of Elastic Shells]. Nauka, 1967) with
respect to the principal types of loading (axial compression, external pres-
sure, and torsion). The geometric method reduces the problem of shell
buckling to a variational problem for the functional $J = L - A_q$ determined
for infinitesimal flexures of the middle surface with cracks along lines on
condition of collinearity of the flexural field and the binormal to the
crack line. Formulas for the term A_q of functional J, representing the work
produced by the external load in the presence of deformation induced by the
flexural field are derived for cases of axial compression, external pressure,
and torsion, assuming a known formula for the energy of elastic deformation
U. In all the cases considered the critical load accompanies local buckling,
and in the case of axial compression the locus of buckling remains indeter-
minate, whereas in the cases of external pressure and torsion the buckling
occurs on the middle line of the shell. In view of the localized nature of
buckling with loss in shell stability, the critical load applied should be
finely adjusted to the nonuniformity of loading and imperfections in shell
shape. It should also be noted that the occurrence of a critical load dur-
ing local buckling means that the findings obtained here for closed shells
apply equally to cylindrical panels whose edges rest on hinged joints.
References: 3 Russian.

THE GENERAL RELATIVISTIC PHENOMENOLOGICAL THEORY OF SUPERCONDUCTIVITY

MAYER, V. and SAL'YE, K., Friedrich Schiller University, Jena, East Germany

[Abstract] General relativistic thermodynamics is generalized to media with order parameters. Then, by proper selection of the free energy, a general relativistic Ginzburg-Landau theory is obtained. Einstein's field equations, Maxwell's equations and generalized Ginzburg-Landau equations are derived for strong gravitational fields. However, they extend only to the area in which microscopic effects are directly manifested. Reversible quantities are found by using direct variation, while irreversible quantities (heat conduction, internal friction and the time-dependent term of superconductivity) are found from generalized Onsager relations. References 36: 13 Russian, 23 Western.

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A STUDY OF SOLUTIONS OF THE ONE-DIMENSIONAL SCHRODINGER EQUATION WITH HARDY
POTENTIAL. S-MATRIX FORMALISM

ARUSTAMYAN, A. M., VERGASOV, V. L. and CHUKHOVSKIY, F. N., Institute of
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[Abstract] A study is made of the problem of reflection of particles beyond
barrier energy on a Hardy potential for which $\theta_o'(x) = b^{-1} + 2^{-1}an(x^2+a^2)^{-1}$
($n = 1, 2, 3,...$). In a physical sense this function corresponds to Bragg
scattering of short-wave radiation in a crystal with a field of elastic dis-
location-type displacements. The formalism of the steady theory of scatter-
ing is used to calculate the reflection of particles from the function in
both the quasi classical and wave approximations. The approach suggested in
this work has the necessary degree of generality from the standpoint of its
applicability to analysis of scattering of particles on an arbitrary poten-
tial. References: 12 Russian.

USSR   UDC 537.521.7

THE PROBLEM OF THE BREAKDOWN OF GAS IN A HIGH FREQUENCY H DISCHARGE

ASMOLOV, YE. S., NOSUK, V. I., Moscow Institute of Physics and Technology

[Abstract] An exact solution is found for the diffusion equation for
electrons in a gas breakdown in a high frequency H discharge for helium and
hydrogen. The new equation is considerably more accurate than earlier
asymptotic equations. The diffusion equation is reduced to a Bessel equation
of zero order and a general solution is derived. Figures 2; references 3:
2 Russian, 1 Western.

USSR   UDC 535.231.4

CONCERNING A GENERALIZED KIRCHHOFF'S LAW

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[Abstract] Kirchhoff's law links the intensity of a body's thermal radiation to its absorptivity. Levin and Rytov ("Teoriya ravnovesnykh teplovykh fluktuatsiy" [Theory of Equilibrium Thermal Fluctuations], Nauka, 1967) proposed a generalized Kirchhoff's law (linear theory) of a somewhat different kind, namely, that the correlation function of thermal radiation is linked to energy dissipation by a field of ancillary point sources. More recently Klyshko (KVANTOVAYA ELEKTRONIKA, Vol 4, 16, 1977, p 1341) proposed and verified on particular instances the existence of universal formulas (a new form of generalized Kirchhoff's law) relating the correlation function of the fluctuational wave emanating from a thermally radiating body to (linear or nonlinear) scattering matrices. In this paper universal formulas of this type are demonstrated by traditional computational methods for bodies capable of emitting and scattering electromagnetic waves in an unbounded linear medium. Correlation matrices of the departing waves are derived with allowance for thermal radiation. References: 3 Russian.

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